ENGINEERING NEWS

SAN FRANCISCO papers say that PROSPER HUERNE, a civil engineer of that city, has commenced suit in New York against H. B SLAVEN, of the American Dredging Co., to recover 4,000 shares of stock in that company.

Mr. HUERNE claims that, knowing M. de LESSEPS personally, he secured a contract to build workmen's barracks on the Isthmus, and later associated with him in this work M. A. SLAVEN. M. de LESSEPS also promised HUERNE a dredging contract, and in time gave him personally a contract to dredge 2,000,000 cu. m. at 32 cts. per meter. HUERNE proceeded to form a stock company and associated with himself HENRY H. LYNCH and H. B. and M. A. SLAVEN, each to have a one-quarter interest in the enterprise. The charge is made that the SLAVENS went to New York to raise capital, and under a report that they could only do this by making large concessions, induced HUERNE to give up 4,000 shares of his 5,000 stock interest. He says he read an agreement to this effect, but that another agreement was substituted for him to sign, absolutely transferring all his interest to the SLAVENS, excepting the dividends on 1,000 shares of stock. He now sues to recover the other 4,000 shares. The same newspaper account says that the Panama dredging contracts have been enormously profitable, and that "the American Dredging Company has made at least $70,000,000 out of its contracts," a figure which should be divided by 10 to be anywhere near the truth.

SOME changes are being made in the plans for the new Chicago lake tunnel. The shore shaft is now deep enough to begin the shore tunnel, but must be sunk several feet further before work can be commenced toward the lake. The troublesome sand pocket is found to extend towards the lake. It is now determined to sink a new shaft south of the one down, and in a point free from quicksand, to be used as the lake shaft, the old one will be utilized for the shore work in tunneling towards the Desplaines St. pumping works and south to the Fourteenth St. works.

As the natural result of putting "a new broom" into operation in the Chicago pumping department, the works have been receiving a thorough overhauling. The new Chief Engineer, Mr. GERECKE, reports that at the North Side Station the pumps were broken at some time in the past and have been "very unskillfully tinkered," with the effect that instead of 932 H. P. being utilized, as indicated by the cards, the actual work has only been 614 H. P.; in other words, the engines have been pumping air instead of water. The compressed air in the pipes exerted a pressure similar to that due from actual water pressure and gave a false record of the work supposed to be performed. Mr. GERECKE figures that as the engine has been in this condition for 9 years, coal has been burned to the amount of $437,350 for which little value has been received. The outside pump cylinders of one of the main engines is burst, and the repairs are of such doubtful efficiency that the cylinders will hardly stand the strain of the proper 942 H. P. called for; to put them in good order will probably cost $50,000. If these charges are true, an expert hydraulic engineer seems to have been sadly needed thereabouts.

WATERVLIET ARSENAL is favored by the Congressional sub-committee on National defences as a site for a Government gun-factory. Gen. TRACEY'S bill now pending appropriates $1,000,000 for establishing a plant at that point; but Gen. BENET offers a bill of a more comprehensive character appropriating $500,000 for the purchase of material and the manufacture of 12-in. breech loading mortars and $750,000 for the establishment of a gun factory. Gen. TRACEY'S bill has been reported favorably, however, to the whole committee and will be sent to the House at an early date.

THE New York State Railroad Commission had a curious experience this week. Obedient to an assembly resolution instructing them to "institute an inquiry toward improved rapid transit facilities in New York City" they advertised a hearing, appeared with their official stenographer, and announced themselves "ready for business"—to a meeting consisting of four reporters and one solitary spectator, Dr. RAINEY of the Long Island Bridge Co., who announced that he had nothing to present! It was a natural result of stepping outside the proper function of such Commissions, which is not to originate action, but to guide or investigate plans originating with others.

A COMMISSION consisting of Messrs. JOS. P. DAVIS, J. J. R. CROES, and HERMAN SHUSTER has been appointed, as we are informed, to give "public hearings" as to the Quaker Bridge dam and report to the Aqueduct Commission. It will appear to engineers that not much good can result from inviting all eastern New York to ventilate their views in the matter, but that is the mysterious way in which some such official matters have to be done. The Commission has our sympathy, and we hope it will survive to make a report.

THE Pennsylvania Company is experimenting with the Westinghouse Standard Heater on one of its trains. The cars are heated from the locomotive by steam which circulates through the train back to the tank, where it is condensed. In the cars the heat is obtained from 2 in. pipes encased in wire network against the sides of the cars. A stationary engine in the passenger station yard heats the cars before the locomotive is attached.

THE New York, Lake Erie & Western R. R. Co. also reports that it is obtaining very satisfactory results from a steam-heating device of its own.

Mr. ANDREW CARNEGIE predicts that the steel rail production will be very small this year and prices lower. Last year the consumption was 2,225,000 tons, or about enough for 22,5000 miles of track. He also predicts that Chicago is to become increasingly important as a steel rail center.

THE Eads Tehauntepec Ship Railway Co. is reported to have decided last week to send Mr. ANDREWS, of Pittsburg, and Mr. WINDOM, of New York, across the Atlantic to interest foreign capital in the enterprise.

A COMPANY is reported as organized for the purpose of piping natural gas to Chicago. The capital required is estimated at $12,000,000, and the company offers to furnish within a year 10,000,000 cu. ft. every 30 days at a price to compete with coal and manufactured gas.

THE new engine loads now being provided for by the C. St. L. & P. Railroad Company, in calculations for their new bridges, will show a considerable excess over the usual loading as given by the heaviest Consolidation engine now in use. The new engine from pony truck to rear wheel of tender is 47 ft. 8 in. in length, and in this distance a total load of 240,000 lbs. has to be provided for. From front to rear driver (four drivers) is 13 ft. 8 in. and on this a total load of 136,000 lbs. The tender has 15 ft. 5 in. from front to rear wheel, with a load of 88,000 lbs.; the pony truck carrying 16,000 lbs.

IN our issue of Feb. 18, a note was given in regard to the tests at the Watertown Arsenal of the asphalt coated wire nails, known as COPELAND'S patent. The power required to pull one of these nails from white oak, should have read 1,054 lbs. per sq. in. of surface, instead of 105 lbs.

THE Naval Construction & Armament Co. has been incorporated in England, with a capital stock of $3,000,000, to build ships of war in England and Spain, and to deliver them fully equipped and armed; to develop new inventions connected with coast defence and to carry on ship repairing and mercantile ship building in all its branches, including mail and passenger steamers of great speed. The company has secured a shipbuilding yard and engine works at Barrow, and in consequence of the Spanish government having decided to reconstruct its navy at a very large expenditure, a shipbuilding yard will be established at Bilbao. Sir NATHANIEL BARNABY, late Director of Naval Construction, is Consulting Naval Architect for the company.

THE Contractors' Association of this city have enjoined the New Croton Aqueduct Commission from awarding the contract for trenching and pipes and pipe laying, from 135th St. to Central Park reservoir, to the firm of O'Brien & Clark at their lump bid of $1,052,305. Bids were asked upon the separate items as above given, and while the lump bid of O'Brien & Clark was the lowest from any one firm, the Association say that by combining some of the separate bids the city would save much money. These bids stand as follows:—Warren Foundry and Machine Co. supplying pipe at $674,730; Wm. E. Dean, for hauling and trenching and laying, $315,624.25. Together these two bids amount to $61,987.75 less than the bid accepted. At the meeting of the Aqueduct Commission, last Wednesday, the complaining contractors were represented by their attorneys, and injunctions were served on the Commission and upon the successful contractors. A lively fight is promised.

IN referring to the St. Clair tunnel in his report, the Canadian Minister of Railways says it will be 5,280 ft. long, with 2,310 ft. under the St. Clair river, and be cylindrical in form and 20 ft. in clear diameter. The greatest depth of water over the tunnel will be 40½ ft., and the least depth 15 ft. The middle 1,500 ft. of the tunnel will be level, with an ascent in either direction of 1 in 50; the total length of the tunnel and its approaches will be 15,150 ft.

IN Russia where steam snow-ploughs are used to a very limited extent, hedges of fir trees along the lines of railway are chiefly depended upon for protection from snow drifts. They are found to be very serviceable.

A RAILWAY company in the south of England is reported as having purchased 10,000 tons of 100 lb. single head steel rail for use on its lines. This will be the heaviest rail in England, though a 90 lb. rail has been in use on some parts of the Great Southern & Western Railway, in Ireland, for more than 40 years.

ALBANY, N. Y., has a bill before the Legislature proposing considerable changes in its municipal organization. Among other things the bill provides for the appointment of a City Engineer, of not less than 10 years experience as a civil engineer, at a salary of $3,500 per annum. The deputy city engineer is to be of 8 years experience and get $1,800 per annum, and the assistant engineer and draughtsman $1,300; leveller, $1,100; rodman, $900 and chainman $750 per year.

THE most serious railroad accident of the week was a head collision, March 4, on the Cincinnati Southern Ry. between Pine Knot and State Line, Ky. One freight train was trying to make Pine Knot ahead of time, and the other had been ordered to State Line without regard to the first. Both engines and several cars were wrecked. Two men were killed and 4 injured.

THE following bridge accidents are reported: On Feb. 26, the upper Rum river trestle, near Anoka, Minn., gave way under a team, the ice having forced the piles so far out of place as to let the stringers down.——On Feb. 28 the abutment of the Beaver Creek trestle, near Reynolds, Ga., gave way. Trains were flagged.——On March 1, a Southern Pacific stock train went through a span of the Hondo Creek bridge, 30 miles west of San Antonio, Tex.; two cars fell 60 ft. into the creek below. The accident is attributed to some timber falling off a previous train and breaking a part of the bridge. The bridge was an iron structure of 3 spans.——On March 2 a bridge was washed out at Norris, Ia., on the Burlington, Cedar Rapids & Northern Ry.

CANADA, having already expended $50,000,000 in canal construction, now proposes to spend $12,000,000 in securing 14 ft. draught from Lake Superior to the sea. The Parliament at Ottawa is now asked to appropriate $3,127,000, of which sum $997,000 would be used to commence a Canadian canal at Sault Ste. Marie. The sum of $1,500,000 is to be used in deepening the St. Lawrence canals to 14 ft. It is claimed with some show of reason that, failing these improvements on the lower canals, the deepening of the Welland and Lachine canals has been an aid to American rather than Canadian transportation interests.

A Discussion of Long Span Bridges.

BY GUSTAV LINDENTHAL, M. AM. SOC. C. E.

(*Continued from page 155.*)

Having shown that suspended wire cable-arches offer great advantages for very long spans, and, in point of fact, it can be asserted without successful contradiction that theoretically it is the best system of all that can ever be proposed, it remains for us yet to show which of three arrangements of ribbed arches should be chosen; whether the three hinged arch (with hinges at ends and one in the middle), or the two hinged (with hinges only at the ends), or the arch with fixed ends, and then having selected the form, how this type can practically be constructed.

The arches being wire cables, must for practical reasons be made of the same section throughout, and therefore they cannot be used for the last class, namely for arches with fixed ends. These, whether now rigidly fixed and anchored (as in the St. Louis Bridge), or fixed by merely abutting against the ends of another arch, require very much heavier sections at the ends than at the middle of the span, partly to resist the transient loads and partly to resist temperature effects.

Not only would it require sections or tensions near the towers nearly 100 per cent. greater than at the middle of the span, but there would also occur compression strains for which the wire cables are not suited. For these reasons ribbed arches with fixed ends are out of the question for wire cables. On the other hand, the construction of hinges in wire cables would be connected with difficulties desirable to avoid. In link-cables hinges are practicable but unsightly. For the sake of better appearance it is preferable to preserve the parallelism of the cables through the towers. This can be done by an arrangement as shown in diagram Fig. 1, which is used in the North Side bridge in Pittsburgh, Pa., and which is an equivalent for an end hinge.

With a similar arrangement it would be possible to introduce the equivalent for a middle hinge between wire cables so that their continuity would be preserved at the same time that provision could be made for the continuity of the web system for shearing strains.

The equivalent arrangement for the cable-supports in the towers has been described, but before deciding what system of hinged arch, whether merely end hinged, or three hinged, should be used, we shall consider the nature of strains in both, and first of all the temperature strains.

5. TEMPERATURE STRAINS IN THREE HINGED ARCHES.

The theoretical advantages of the three hinged arch are generally assumed to be the calculation of strains from loads on statical principles, and therefore with great precision, and, more important yet, with freedom from temperature strains. The first advantage can only be admitted conditionally, but the second does not exist, and there is no doubt that in this the generally accepted theory is erroneous. There are of course no temperature strains at the middle hinge, but they do exist for any change from the normal temperature in the connected half-arches.

For the following investigations we will assume letter references from the annexed figure to be as follows:

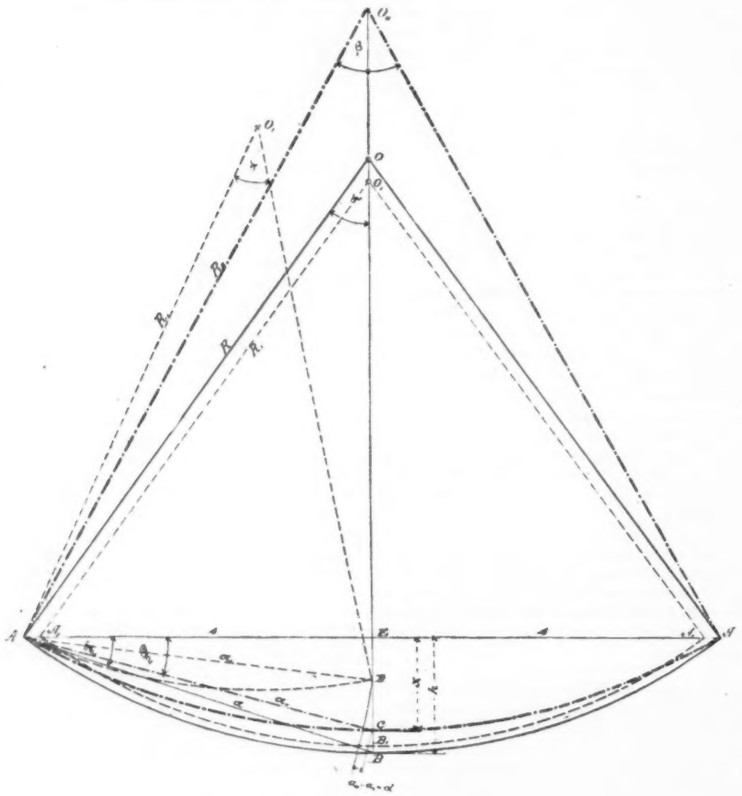


Fig. 2.—Diagram of Temperature Strains.

$A\,A = 2s$ = Length of span.

$A\,O = R$ = Radius of a flat circular arch at mean temperature (say 50° F.)

$A\,O_1 = R_1$ = Radius of a similar arch, changed by temperature, on free supports.

$A\,O_{11} = R_{11}$ = Radius of equilibrium arch at changed temperature, on fixed supports.

h = Deflection of arch at middle temperature.

x = Deflection of equilibrium arch of radius R.

a = Chord line of half arch, radius R.

a_1 = Chord line of similar arch, radius R.

a_{11} = Chord line of half of equilibrium arch, radius R.

t = Number of degrees of temperature.

e = Change of length per degree of temperature.

$a_{11} - a_1 = d$ = Difference in length of respective chord lines.

To facilitate the investigation, the arch is assumed to be of circular form. As a rule, flat stiffened arches are built as part of a circle. The difference between flat circular, parabolic or catenary arches is so slight, that it can be neglected in practice. The arch may be erect, or inverted, it may be stiffened as (in this case) in the form of a rib, or it may be a so called spandrel-braced arch, or the combination of an arch and stiffening truss, or any other known form of arch with a middle hinge; the results of the investigation apply to all of them.

An analysis of the problem, starting out with the theory of elasticity and then on certain premises finding a general law for the change of the curvature in three hinged arches, leads to complex formulæ of little practical use. The following solution is much simpler and gives formulæ for flat catenaries, which are close approximations:—

$A\,A$ are the points of fixed arch-supports. Assuming for a moment that an iron brace $A\,A$ were inserted to form a bow string-girder, then on contracting from cold, for instance, all parts of the girder would contract at the same rate, and the arch would assume the form $A_1\,B_1\,A_1$ which is similar to $A\,B\,A$ and in which the center angle α remains unchanged.

We can then write arc $A_1\,B_1\,C_1$ = arc $A\,B\,A\,(1 \pm t\,e)$, and chords $A_1\,B_1 = a_1 = A\,B\,(1 \pm t\,e) = a\,(1 \pm t\,e)$; te is the amount of change in length, proportionate to the temperature and it is immaterial for the investigation whether the sign is positive or negative.

If we now assume the hinges connected by rigid ties or braces $A_1\,B_1$ and the supports $A_1\,A_1$ rigid and immovable, then the only possible way for the arch to rise would be by assuming the position $A\,D\,A$, in which $A\,D = A_1\,B_1 = a_1 = a\,(1 \pm te)$. The tangents to point B of the normal arch are in a straight line, but for the contracted (or expanded) arch they form an angle.

The condition of equilibrium in the arch requires that these tangents at D remain in a straight line, and therefore the arch will assume the form $A\,C\,A$ of which the radius is R_{11} and the center angle β

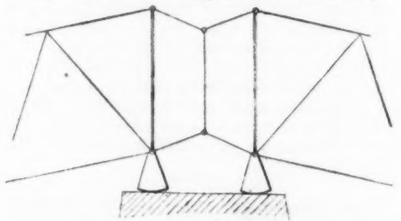


Fig. 1.

From the figure it is clear that the lowering of the middle hinge from D to C would produce tension in the assumed rigid chord line $A\,D$ and that the lengthening (in the case shown in the figure) of $A\,D$ to $A\,C = a_{11}$ will produce bending moments in the half arches.

If the arch were made of rigid, inelastic material the arch center of either half arch would not coincide as they should; the arch centers would move from O to O_1 and center angle α for either half arch would remain unchanged. But as iron and steel are elastic materials, the arch will tend to assume the equilibrium form ACA, in which the length of arc $A\,C\,A$ will be equal to arc $A\,B\,A\,(1 \pm te)$.

In order to find the bending moments in the half arches it will be convenient to find the difference $d = a_{11} - a_1$, of length of chord lines laid through the end and middle hinge, and to insert it in the general formula for temperature strains in two-hinged arches, because each *half arch* will be affected similarly to an arch hinged at the ends only.

This general formula is a near approximation, and is deducted from the theory of flexure as applied to parabolic arches, namely:

$$H = \frac{15\;E\,I\,2\,tes}{16\,h^2\,s} \qquad (1)$$

in which H is the force acting on a straight line laid through the end hinges and producing the change of curvature.

E = is the modulus elasticity.

I = is the moment of inertia of arch section (or of the stiffening girder.) and $2\,tes$ is the amount of change in length of chord line $A\,A$.

In an end hinged arch the force H is in a horizontal line (usually), and multiplied by the ordinate at any point of the arch will give the bending moment at that point; its maximum is therefore at the middle of the arch and it diminishes to zero at the end hinges.

In the three-hinged arch the similar force H_1 is acting on the line through the end and middle

hinge. There will be two maximum bending moments, one at the middle of either half arch. By substitution of the corresponding new values in formula (1) we obtain for the force

$$H_1 = \frac{15\,E\,I\,d}{8\,K^2\,a_1} \quad \text{(2)}$$

in which K is the normal at middle of chord line (or the height of half arch) and $a_1 = a\,(1 \pm te)$.

In a wire cable arch, as for the proposed North River bridge, the cross section of the arch-rib and therefore I, the moment of inertia, is uniform. Therefore, the proportion of H to H_1 from formulæ 1 and 2 will be:

$$\frac{H}{H_1} = \frac{te\,K^2\,a\,(1 \pm te)}{h^2\,d} \quad \text{(3)}$$

In order to find the value of d we take from the figure the following relations.

$$R_1 \text{ arc } \alpha = R_{11} \text{ arc } \beta \quad \text{(4)}$$

$$x = s\ tang.\ \frac{\beta}{2}$$

$$h = s\ tang.\ \frac{\alpha}{2}$$

$$\frac{x}{h} = \frac{tang.\ \frac{\beta}{2}}{tang.\ \frac{\alpha}{2}}$$

The difference between angles $\frac{\alpha}{2}$ and $\frac{\beta}{2}$ is comparatively small and it is in this case a sufficiently close approximation to write for

$$\frac{tang.\ \frac{\beta}{2}}{tang.\ \frac{\alpha}{2}} = \frac{arc.\ \frac{\beta}{2}}{arc.\ \frac{\alpha}{2}}$$

so that we can say

$$\frac{x}{h} = \frac{\beta}{\alpha} = \frac{R_1}{R_{11}} \quad \text{(5)}$$

In the case, when $h = x_1$ then $R_{11} = R_1$, and for $x = 0$, $R_1^{\text{I}} = \infty$

We have the further relation

$$R = \frac{h^2 + s^2}{2h}$$

$$R_{11}^2 = (R_{11} - x)^2 + s^2$$

$$R_{11} = \frac{s^2 + x^2}{2x} \quad \text{(6)}$$

combining equations (5) and (6), we have

$$\frac{x}{h} = \frac{2x\,R_1}{s^2 + x^2}$$

substituting for $R_1 = R\,(1 \pm te)$ we find for $x^2 - 2\,R\,(1 \pm te)\,h = s^2$ and

$$x = \sqrt{2\,Rh\,(1 \pm te) - s^2} \quad \text{(7)}$$

we have the further relation $A_{11} = \sqrt{x^2 + s^2}$

Substituting value for x from equation (7) and reducing we obtain for $a_{11} = \sqrt{2\,Rh\,(1 \pm te)}$ (8.)

By substitution of values in $d = a_{11} - a_1$ we obtain d in known terms

$$d = \sqrt{2\,Rh\,(1 \pm te)} - (1 \pm te)\,\sqrt{h^2 + s^2} \quad \text{(9.)}$$

The value for K is given by the formula

$$K = R_1 - \sqrt{R_1^2 - \frac{a_1^2}{4}} \quad \text{(10)}$$

for which it is most convenient to first find the numerical values of $R_1 = R\,(1 \pm te)$ and $a_1 = a\,(1 \pm te)$ and then to insert them directly into the equation.

Likewise will it be more convenient to find the numerical value of d from equation (9) and then to insert the so obtained values of d and K into formula (2) for H^1.

The bending moments from temperature changes in each half arch can thereupon be calculated in the same manner as for an end-hinged arch, and these effects combined with the calculated effects from moving loads, will give by superposition the strains from the maximum moments in three hinged arches.

In a suspension bridge, having one middle span and two end spans, the temperature effects will be concentrated in the middle span, the end spans having no temperature strains. Therefore the rate of expansion or contraction $\pm te$ is to be taken for the whole length L of suspended superstructure and the corresponding rate of expansion for the middle span $2s$ will be $f = \frac{L\,te}{2\,s}$, which is to be substituted for te in formula (9) to obtain the value of d for the middle span of a suspension bridge. The length $2s$ of middle span is not fixed for such an arrangement. It will be more in winter and less in summer, but this movement is comprised in the value $\frac{L\,te}{2\,s}$.

The change in the ratio $\frac{2\,s}{h}$ from this movement is so small that the slight variations in the direct stresses of the arch, resulting therefrom, can be neglected. It is immaterial then, whether the supports $A\,A$ are fixed and length of arch changing, or whether the supports are movable, and length of arch not changing, or whether there is a combination of both these conditions. As long as the *relative* change of length between chord line and arch is the same, the resulting bending moments are also the same.

As already stated, the tangents to arch at middle hinge should remain in a straight line, and it is desirable, that the extremes of temperature should not change this condition; in other words, the arch should not kink in at the middle hinge from temperature changes. For if it does the bending moments from live load can become excessively large and even dangerous, unless specially provided for. Hence there is a limiting value for H, in three hinged arches, which should not be exceeded in a well designed bridge.

A three-hinged arch can be regarded as two inclined bow-string girders hinged together. The reaction of each girder at the middle hinge is equal to half its own load. If the curved chords coincide with the equilibrium curve for the whole uniform load, then no bending moments can exist in the bow-string girders. But if the curved chords do not coincide with the equilibrium curve, then the reactions from the girders on the middle hinge will produce two forces, each on a line from middle hinge to either end hinge and the value of these forces would be equal to $\frac{pn}{4}\,s\ cotang\ \frac{\beta}{2} = \frac{1}{4}\,pn\,\sqrt{x^2 + s^2}$

in which $p\,n$ is the uniformly distributed dead load of the bridge.

Therefore the maximum force, producing bending moments from temperature changes under any possible circumstances should not exceed

$$H^1 \max = \frac{pn}{4}\,\sqrt{x^2 + s^2} \quad \text{(11)}$$

It is evident from formula (2) that the bending moments increase, aside from the temperature change, in direct ratio to E (*i. e.* with the rigidity of the material) and to I (*i. e.* with the square of depth of arch rib) and in inverse ratio to h (deflection or height of arch).

The weight of the bridge has very little influence on the bending moments from temperature changes within the extremes of our climate, and it can be neglected for two-hinged arches. But in three-hinged arches the limiting value of H_1 should be dependent on the weight of the bridge. For a small dead load (or for hard steel) the height of arch should be taken greater than for larger spans, and greater than for soft steel or wrought iron. (The smaller modulus of elasticity of cast-iron is no doubt the saving cause of many flat cast iron arches, in which no special provision against temperature strains has been made.)

From formula (3) we obtain the proportion of the maximum bending moments respectively in two and three hinged arches, having the same arch section, by multiplying H and H_1 with the corresponding ordinates at middle, namely h and K.

$$\frac{H\,h}{H_1 K} = \frac{f\,K\,a\,(1 \pm f)}{hd}$$

for the middle span of a suspension bridge the numerical results of this formulæ will give an idea of this proportion of bending moments in each given case. For the proposed North River bridge, having from the nature of its construction a uniform modulus of elasticity and uniform moment of inertia, the numerical results show the temperature-bending moments for a three hinge arrangement to be twice as great as for end hinges only,—a result, which certainly did not commend the use of a middle hinge (or equivalent) to favor.

There is room for the belief that the actual stresses from temperature changes will in practice be smaller than the calculated values, particularly in pin connected arches. The pins rarely fit tighter than $\frac{1}{10}$ in., so that a certain initial movement in the frame is possible before any strains from changes in curvature are set up.

There is, moreover, the effect of the change in the height of iron towers from changing temperatures, the friction of the cable supports on the towers, the simultaneous effect of wind, the lassitude with which the strains travel through the web-bracing as compared with the quicker rate of transmission in the arches or cables, and the modifying bending moments, which are solely due to change of curvature from the direct stresses in the members caused by either the transient loads or by temperature changes on the arch chords and web-bracing (and which the above theory of temperature strains does not consider.

The influence of some of these varying conditions can be estimated approximately, others we can judge of only from actual experience, but on the whole the calculation of the strains without special regard to them will give results on the safe side of the line. The rise and fall of the arch center is the same for two and three-hinged arches, as long as the calculation shows that the arch will not kink at the middle hinge.

In regard to the calculation of the load effects on statical principles, it has already been remarked that the obtained results are not strictly accurate, because the change of curvature in the arch from the loads is usually not considered. If the material of the arch were absolutely rigid, then the negative and positive bending moment from moving loads would be equal in the manner usually assumed. But since iron and steel are elastic, the bending moments are affected by the change of curvature; the error, however, from this cause is also apt to be on the safe side.

In large spans it is important to trace the different effects, for accurately determining the dimensions, so that all superfluous weight may be saved as a matter of economy as well as for the greater safety of the structure.

From the foregoing it will be understood that end hinges are best adapted to inverted arch ribs, composed of two wire cables with web-bracing between them. The uniform cross-section of such an arch is in strict compliance with the assumptions for calculation, whereas, when the cross-section changes, as it usually does in other forms of arch construction, the assumed and actual arch sections do not correspond nearly as well. The bending moments from transient loads are, moreover, smaller in two-hinged as compared with three-hinged arches, and they are more evenly distributed. Likewise the bending moments from temperature changes are smaller. The maximum is at the middle of the arch just where the cable strains from dead and live load are smallest. As the cable sections have to be proportioned for the maximum tension, which occurs in the end spans near the towers, the excess of section at the middle span, in the case of wire cables, can be made convenient use of to meet the temperature strains.

A further comparison of the two classes of arches shows that the two hinged arch is more economical in material. The arch with fixed ends, or with merely abutting ends, is obviously not a suitable form for cable arches. There are bending moments at the ends, requiring much larger sections there than at the middle of span.

This class of metal arches, whether inverted or erect, requires very accurate workmanship, and very precise adjustment of lengths, which, if obtained during erection, it is difficult to maintain under hard usage. They are too sensitive to small accidental defects in erection, and the strength and safety of arches with fixed ends depends too much on nice assumptions, which it would be too difficult to obtain in practice for very long spans.

The claim that they are more rigid than two hinged arches is not well founded. The St. Louis bridge is the finest existing example of arches with fixed ends, and it sways no less (if not more) on account of the low ratio of dead to live load, resulting from the use of high steel, than other arch bridges with two or three hinges. This swaying must be attributed to the unstable equilibrium of erect arches as against the rigidity of inverted arches, which are in stable equilibrium.

(TO BE CONTINUED).

The Use of Steel Tapes in Surveying.

(*Concluded from page 160.*)

Limits of Error. Fifty-foot Tape. Line one-half mile long. Accuracy 1 in 2,000.

The following limits of accuracy are given in the order of their importanee:

1. True length of tape to ¼ of $\frac{50}{2,000} = 0.006$ ft.
2. End marks on ground made and connected with the limit $E = ¼ \times \frac{1}{2,000} \times 50\sqrt{53} = 0.045$ ft.
3. Combined sag and stretch effect known to the limit of 0.02 ft.
4. Slope effect known to the limit of 0.02 ft.
5. Temperature correction (average of line) known to the limit of 0.006 ft.

Since most field measurements would be made with the tape freely suspended from the ends, it should be tested in this way, when its absolute length is determined. Thus every tape should have its absolute length determined for a certain standard pull which is to be used in all field measurements, and for a temperature which should be about the average of the temperatures at which the tape is to be used. This average temperature is much higher than 62° Fahr., which is a grand average of all day and night temperatures for the year. There are three causes for raising this average for field work: 1. The work is done only in the day time. 2. It is mostly done in summer, or in the less severe winter weather. 3. The temperature of a steel tape in the sun is considerably higher than that of a thermometer in the shade, which is always used in the weather service records. It is the writer's opinion that a temperature of 80° Fahr. would be about a fair average for steel tapes.

For the tape here specified, the increased length from pull will be exactly balanced by the shortening from sag, if the pull be 9 lbs. In this case a 9-lb. pull with tape hanging freely, will give the same distance between end marks as a very slight pull with tape lying on the ground. It is best to always use a pull when suspended, which will just overcome the effect of the sag, and this pull we will call the "Normal Tension."

We will suppose, therefore, that the absolute length of the tape is known for a 9-lb. pull hanging freely at a temperature of 80° Fahr. Then that the combined sag and stretch effect shall not exceed 2.02 ft. on one tape length, the pull must not be less than 5, nor more than 32 lbs. and to make the slope error less than 0.02 ft. in 50 ft. the angle with the horizontal must not be more than 1° 37', or 1.4 ft. difference of elevation of the two ends. The temperature also must not be more than 17° Fahr. above or below the standard. To measure a line on ordinary rolling ground, with a 50-ft. tape, making the end marks to within half an inch, maintaining the pull to within 4 lbs., keeping the tape horizontal to within 1.4 feet difference of end elevations, and estimating the average temperature of the tape to within 17°, is surely not a difficult matter for practiced chainmen, and of course no others would be used on such work. Experienced chainmen are as necessary to good surveying, and should be as essential a part of a surveying party, as the instruments themselves.

The relations between the sag and the shortening effect of the same, the stretch, the pull, and the weight of the tape are well shown in the accompanying diagram. The horizontal distances give the values of $\frac{P}{w}$, where P is the pull in pounds, and w is the weight in pounds of *one foot* of the tape. The left vertical coördinate scale gives the errors from sag and pull for 1,000 ft. of distance (full line curves), and the right scale gives the actual sag, at the center of 50, and 100 ft. tapes, for corresponding values of $\frac{P}{w}$. The sag errors are marked minus, and the pull errors plus. Where these lines cross, these two errors exactly compensate each other, as is the case with a 50-ft. tape for $\frac{P}{w} = 900$. But for our tape $w = 0.01$ lb. therefore $\frac{P}{w} = 900$ when $P = 9$ lbs., as stated above. Therefore a 9-lb. pull on this tape mutually destroys these two errors. The same tape 100 ft. long would require 14½ lbs. pull to accomplish the same results.

From this diagram we are enabled to select a tape which will eliminate these two sources of error for convenient pulls. Thus if 10 lbs. should be chosen as the standard pull, this then becomes our "normal tension," or the tension which eliminates these two errors. If our tape is to be 100 ft. long then we have, from the diagram $\frac{P}{w} = 1450$ or $w = \frac{P}{1450} = \frac{10}{1450} = 0.00689$ lbs. This gives a cross section of 0.002 sq. in., which is a common size for long tapes.

For a 50-ft. tape of this cross-section, we have, from the chart, $\frac{P}{w} = 900$; or $\frac{P}{0.00689} = 900$; or $P = 6.2$ lbs. as the normal tension for a 50 ft. tape of 0.002 sq. in in cross-section.

CITY WORK.

For city work an accuracy in the final result of 1 in 5000 should be attained. Applying the same arguments to this case, still using a 50-ft tape we would have:

1. True length of tape known to ¼ of $\frac{50}{5000} = 0.0025$ ft.
2. End marks on ground made to a limit of $¼ \times \frac{1}{5000} \times 50 \times \sqrt{u}$. Here the average length of line measured will be assumed as 450 ft. giving $u = .9$ whence $e = \frac{3 \times 50}{4 \times 5000} = 0.0075$ ft.
3. Combined sag and stretch known within a limit of say, 0.005 ft.
4. Slope effect less than the limit of 0.005 ft.
5. Temperature change (average of the line) known to the limit of 0.0025 ft. If the cross-section of the tape is 0.002 sq. in., then $w = 0.00689$, and the normal tension is as above, 6.2 lbs.

To find the variation of tension to give a combined sag and stretch effect of 0.005 ft. we must enter the diagram for the correspondent effect on 1,000 ft., which would be $20 \times 0.005 = 0.1$ ft. The pull and sag lines on the diagram, for a 50 ft. tape, deviate by 0.1 ft. at $\frac{P}{w} = 700$ and also at $\frac{P}{w} = 1300$. This corresponds to pulls of 4.8 lbs., and of 8.96 lbs. or say 5 and 9 lbs. Therefore, the pull on the tape must not be less than 5, nor more than 9 lbs., the "normal tension" being 6.2 lbs. This allows a variation of 1.2 lbs. below and 2.8 lbs. above the normal. Practiced operators will always be able to produce a tension within these limits without using a pair of scales.

The slope effect of 0.005 ft. corresponds to a difference of elevation of ends of some 8 ins. On ground of a nearly uniform slope, or on hillsides, it will be impossible to fix a horizontal line by eye within this limit, and some mechanical appliance will be necessary. As good as can be used, probably, would be a small wooden T square strung on each plumb line, moving freely but staying where it is set. The line should pass through the axis of the stem of the T so as to balance it on the line. The upper edge then gives the horizontal, each chainman having one for his guidance.

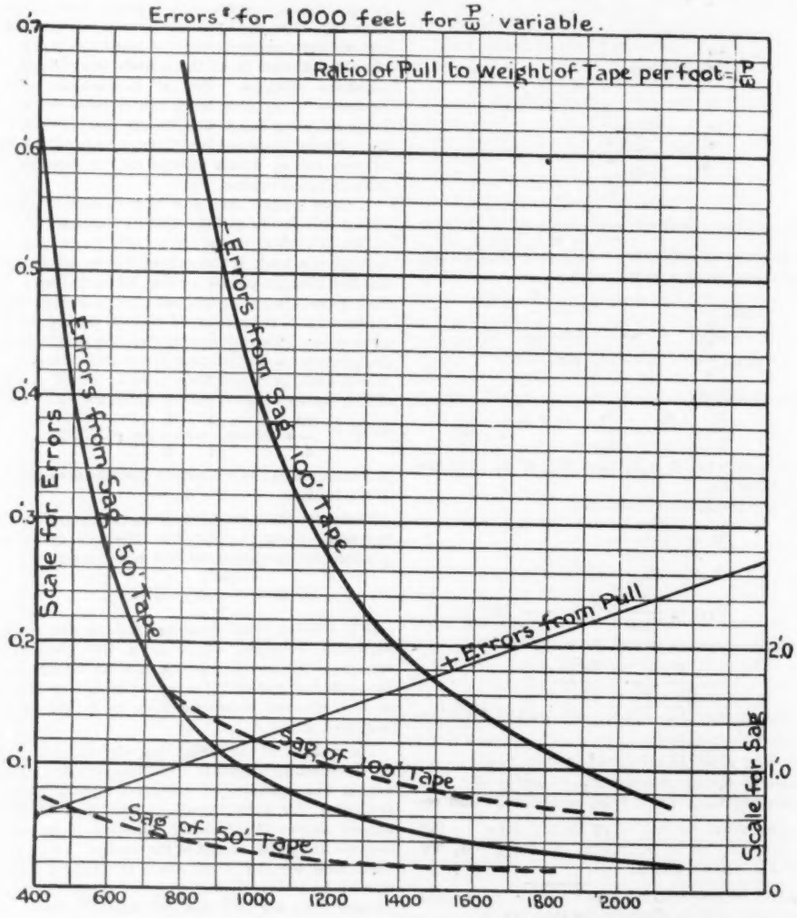


Diagram Showing the Relations of Sag, Stretch, Pull and Weight of Steel Tapes.

The temperature error of 0.0025 ft. in 50 ft., corresponds to a variation in temperature of 7° Fahr. If the average temperature of the tape on the work varies from the standard by more than this amount, a correction should be applied. The coefficient of expansion of steel tapes varies from 0.000005 to 0.000007, but perhaps 0.0000065 would be a fair average.

To obtain the end marks to an accuracy of 0.0075 ft. or 0.09 in., with suspended tape, two plumb lines being used, requires a considerable practice, steady nerve, and constant care, but it can be done. If one end mark can be held to the ground so much the better, but even when both ends are plumbed, if there is not too much wind, the marks can be obtained to this degree of accuracy. If there is any uncertainty about it, several trials should be made and the mean taken.

To obtain the true length of the tape to an accuracy of 0.0025 ft., or 0.03 in., is the severest requirement on the list. No manufacturer's certificate is sufficiently reliable. So called U. S. standards are known to differ by as much as $\frac{5}{8}$-in. in 50 ft. Even when the temperature at which the tape is supposed to be standard is given, still we do not know the pull it was subjected to in making the test. There is therefore no certain way of learning the true length of a steel tape, at a given temperature and pull, except to have it compared, by practiced observers, with some other tape whose constants are known.

GEODETIC WORK.

The unit of length in all geodetic measurement is the length of the base line, which is measured with great accuracy. In our large primary systems of triangulation an accuracy of about 1 in 1,000,000 is sought and usually obtained. Very elaborate apparatus, of many different designs, have been used for this purpose, the labor of performing the field work and also the office reductions usually being on a correspondingly elaborate scale. It has been fully proved, however, in America, by Mr. O. B. WHEELER, U. S. Asst. Eng., in the survey of the Missouri river, as well as by the writer himself in students' practice surveys, and in other experimental work, and in Europe, by Mr. JADERIN, of Stockholm, that this same degree of accuracy may be obtained, at a greatly reduced cost of time and labor, with an ordinary steel tape, of from 100 to 500 ft. in length. These methods of observation and reduction will not be elaborated here, but they may all be found in the writer's work on the "Theory and Practice of Surveying," John Wiley & Sons, New York, 1886.

The fact of such great attainable accuracy in the use of the steel tape is here stated simply to convince engineers and surveyors of the wonderful range of possibilities of this useful appliance. Thus it is seen that for all purposes of length measurement in the field, from the most rapid reconnaissance to the greatest attainable accuracy, the steel tape is the most convenient and accurate instrument that can be used.

THE COMPLETE STANDARDIZING OF A STEEL TAPE.

The standardizing of a steel tape consists in determining:

1. Its area of cross-section.
2. It sabsolute length for a given pull, supported in a given manner and at a given temperature.
3. Its co-efficient of expansion.
4. Its modulus of elasticity.

When these are all known, then its true length can be exactly computed for any pull or system of supports, or for any temperature. Furthermore none of these qualities can safely be assumed. The co-efficient of expansion varies by 40 per cent., and the modulus of elasticity by at least 20 per cent. If the tape is to be used for no greater degree of accuracy than 1 in 5,000, as in city work, then these qualities may be assumed to be about the average. In such cases assume the co-efficient of expansion at 0.0000065 for 1° Fahr., and the modulous of elas ticity at 28,000,000. If the pull used is always the same as was used in the standardizing experiments, then the modulus of elasticity need not be known.

The weight per foot in pounds may be taken as 3.4 times the area of the cross-section in square inches. The area of the cross-section is, however, best determined from the weight per foot. Thus if a tape 50 ft. long weighs 0.5 lb., then each foot weighs 0.01 lb., and the area of the cross-section is $0.01 \div 3.4 = 0.003$ sq. in.

In the most accurate work, whether in the field, or in comparison with a standard, it is necessary to obtain the pull to the greatest possible accuracy, and to insure that this is uniform throughout. When intermediate supports are used, all friction on such supports must be eliminated. To accomplish this the pull is obtained by hanging the stretching weight from a bell crank of equal arms, which is kept in a fixed position by an adjusting screw, and the tape is suspended in hooks at the points of support, which hooks are adjusted to a vertical position.

With these precautions, the absolute length for the given pull, system of support, and temperature, can be obtained from a single comparison with a standard tape. To find the co-efficient of expansion requires two comparison with such standard at temperatures as widely different as possible. These temperatures should differ by at least 30° F. Then the co-efficient of the standard being known, that of the compared tape can be computed. All this is comparatively simple after one tape has had its constants carefully determined. Until recently, it is safe to say, there was no tape in America whose constants were known. At the present writing (Jan. 1888), there are three 300-ft. tapes in America whose constants are known. The original one is the property of the Mississippi River Commission, and the other two belong respectively to Washington University, St. Louis, Mo., and to Washington and Lee University, Charlotteville, Va. These latter have been determined by comparisons with the Mississippi River Commission's standard. This original standard had its absolute length determined by twice measuring a portion of the Olney Base Line (Ill.), of the U. S. Lake Survey, which had been twice measured by the Lake Survey primary base apparatus, this being of the most approved pattern, and gave results to an accuracy of 1 in 1,000,000. Its co-efficient of expansion was determined by the writer by continuous readings by fixed micrometer microscopes on its end graduation for 4 days and 3 nights, the tape being entirely enclosed in a wooden box 300 ft. long, supported by suspended hooks, and stretched by a weight so arranged as to give constant tension. The range of temperatures obtained was 55° F., and a co-efficient was obtained of 0.00000699 with an error not greater than 3 in the last place. Its modulus of elasticity was obtained at the same time and found to be 27,400,000. It is certain that no other tape in America has ever had its constants determined with anything like the accuracy obtained for this one, and hence as a standard with which to compare other tapes there are no others in this country which deserve to be called standards, except those which have been carefully compared with it. The Washington University Standard is available for the standardizing of other tapes, and such comparisons will be made on application to the writer.

For further information as to methods of observation, reduction and derivation of equations, etc., see "Theory and Practice of Surveying," by the writer; "Report of Missouri River Commission, St. Louis, 1886;" "Geodätische Läugluessung mit Stahlbäuden and Metaldrähten," by EDW. JADERIN, Stockholm, 1885, 57 pp.; and "Exposé elémentaire de la nouvelle Methode de M. EDOUARD JADERIN pour la mesure dro dwites geodetique au moyen de Bancles d' Acier et de Fils métaliques," by P. E. Bergstraud, Stockholm, 1885, 48 pp.

Economy in the Composition of Cement Mortar.

IRA O. BAKER, PROFESSOR OF CIVIL ENGINEERING. UNIVERSITY OF ILLINOIS.

There is great diversity in the practice of different engineers and architects in specifications for the use of mortar. The latter frequently employ lime mortar, where true economy would require the use of a rich Portland cement mortar, since it is frequently better to use better mortar and thereby decrease the thickness of the wall. Sometimes engineers require the use of expensive Portland cement mortar when mortar made of the cheaper Rosendale type† of cement is ample. This article was suggested by the fact that a firm of eminent engineers employs a mortar composed of 1 volume of Portland cement and 3 volumes of sand, as being equal in strength to one composed of 1 volume of cement, of the Rosendale type, and 2 volumes of sand; the former costs nearly double the latter and will attain to nearly one-third greater strength, or, in other words, a 1 to 4 Portland mortar is at least equal to a 1 to 2 Rosendale mortar. Large sums of money are spent annually for cement; possibly the following discussion may enable someone to save part of this expense, and also help to a better understanding of one phase of a complicated subject.

ROSENDALE VS. PORTLAND CEMENT.—It s some times a question whether Portland or Rosendale cement should be preferred. Generally this question is to be decided on economical grounds, when it becomes a question of relative strength and relative prices; but frequently it is determined by other elements. Thus, if great ultimate strength is required, then Portland cement must be used; and if a quick-setting mortar is desired, then Rosendale cement must be employed.

Unless a quick-setting mortar is required, there is an advantage in using Portland; it sets slower, and hence is not so liable to set before reaching its place in the wall. This is an important item, since with quick-setting cement any slight delay might necessitate the throwing away of a box-full of mortar, or the raising of a stone to scrape out the partially set mortar.

It is sometimes very desirable to have a cemen which will set more quickly than Portland, and finally attain a greater strength than Rosendale.

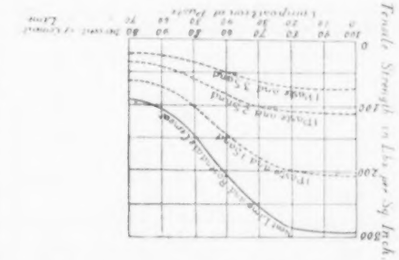


Diagram Showing the Effect of Adding Lime to Cement Mortar.

Under such circumstances a mixture of Portland and Rosendale can be used: "such mortars set about as quickly as if made with Rosendale cement alone, and require great subsequent strength due to the Portland cement contained in them. This was proven by many experimental tests." * The strength of the mixed mortar is almost exactly a mean between that of the two mortars separate.

LIME AND CEMENT.—The advantages of a slow setting mortar can be obtained by mixing common lime with a rich Rosendale mortar. *The lime should be reduced to a paste before being added to the cement.* The addition of the lime gives the double advantage of rather slow-setting mortar and a cheap mortar.

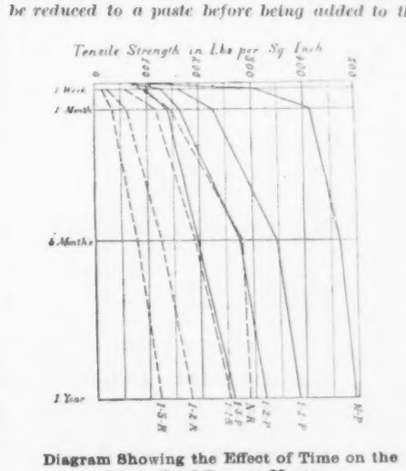


Diagram Showing the Effect of Time on the Strength of Cement Mortar.

Fig. 1 shows the effect of mixing lime and Rosendale cement. The upper line gives the strength of a mixture of Rosendale cement and lime; not enough experiments could be found to warrant the plotting of a curve for a mixture of Portland and lime. It seems that the addition of lime mortar to cement is comparatively more serious with Portland than with Rosendale; when the lime paste is equal to, or exceeds, the cement paste there is practically no differnece whether Portland or Rosendale as used.

The line for neat lime and Rosendale cement is fairly well determined; the lines for the above paste mixed with sand are drawn on the assumption that adding sand to a paste of cement and lime has the same effect, proportionally, as adding sand to a paste of neat cement. A few experiments have been found

† This term is here used as including all so called American natural cement.

which seem to support this conclusion; none have been found which contradict it.

Notice, that the addition of 20 to 25 per cent. of lime paste has only a slight effect upon the strength of the resulting mortar; but it will materially reduce the cost.

STRENGTH OF CEMENT MORTAR.—Fig. 2 shows the effect of time on the tensile strength of cement mortars of different proportions of sand. The diagram was constructed from the "Record of tests of Cement made for Boston Main Drainage Works."*

"The results were compiled from about 25,000 breakings of twenty different brands, and fairly represent the average strength of ordinary good cements of the two kinds." The diagram is instructive in several ways. It "shows that Portland cement acquires its strength more quickly than Rosendale; that both cements (but especially, Rosendale) harden more and more slowly as the proportion of sand mixed with them is increased; that, whereas neat cements and rich mortars attain nearly their ultimate strength in six months or less, weak mortars continue to harden for a year or more. The table shows the advantage of waiting as long as possible before loading masonry structures, and the possibility of saving cost by using less cement when it can have ample time to harden. It also shows that Portland cement is especially useful when heavy strains must be withstood within a week."† Until about 24 hours after mixing, the Rosendale is the stronger.

The line for the strength of lime mortar is probably the maximum value that can be obtained by exposing the mortar freely to the air in small briquettes. This line is not well determined. Some very old lime mortars from the south of France showed an average strength of 70 lbs. per sq. in.‡

Fig. 3 shows the effect of varying the proportions of cement and sand, and also shows the relative strength of Rosendale and Portland mortars at different ages. The curves are specially useful in discussing the question of economy in the use of cement.

The diagrams represent the average strength of a vast number of experiments, certainly 40,000 or 50,000, and possibly twice that number; all available data were plotted, and the lines representing the strength were drawn so as to most nearly represent the mean of all the experiments, due attention being given to the relative reliability of the different individual results and to the character of the curve. Since the individual values plotted were generally themselves means, there were no very erratic results, and consequently the lines are quite reliable. There were fewer experiments for the larger proportions of sand to cement; hence the curves are less accurate the larger the dose of sand.

Usually hard burned, *i. e.* heavy, cements when tested neat, will show a greater strength than that given by the diagram; very heavy and carefully prepared Portland cement has shown an ultimate strength of 1,000 to 1,200 lbs. per sq. in. Very fine cements, when mixed with sand, will show a greater strength than that given by the table. The diagrams are intended to give fair working values.

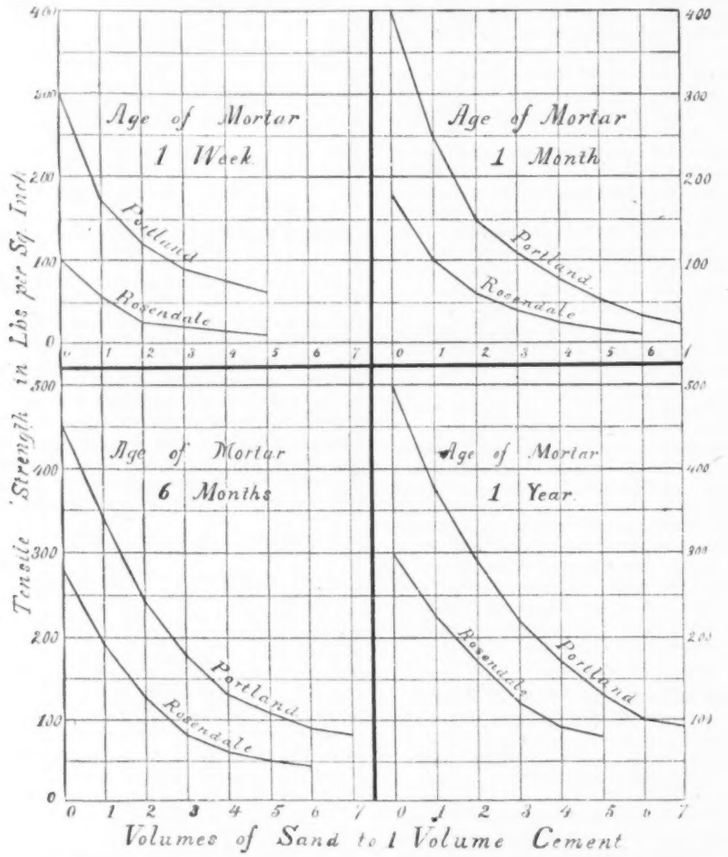


Diagram Showing the Effect of Varying the Proportions of Sand and Cement.

QUANTITIES OF INGREDIENTS REQUIRED.—The following table shows approximately the quantities of cement and sand required for a cubic yard of mortar of different proportions of cement and sand. The quantities in the table are deduced from the results of actual trials §; but at best they can be only approximate, since much depends upon the varying conditions of dampness and dryness, looseness and compactness, fineness, degree of burning, etc. It is believed the table will be very useful in making estimates of the amount of sand and cement required for a particular job. Of course, to determine the amount of mortar required, demands that the ratio of masonry to mortar be known, but that phase of the question is no part of this article.

In experiments on the strength of mortars, it is customary to measure both the cement and sand loose, (*i. e.* not compacted); but in practice it is very common to mix a barrel of cement, as it comes from the manufactory, with certain number of barrels of sand measured loose. The Portland cement and also the cement of the Rosendale type made on the Hudson river are compacted in the barrels when shipped; a unit of volume measured loose is compressed to 0.7 or 0.8 of its former volume. The left hand side of the table is intended to give the quantity required when a commercial barrel of either of these cements is mixed with a given number of barrels of sand.

The cement made west of the Hudson is not compacted so much; the barrel is larger and the net weight of the cement less. Western Rosendale is compacted about 10 per cent. The former weighs 300 lbs. net per barrel; the latter 265 lbs. net. Hence if it is desired to mix mortar by using the commercial barrel of Western Rosendale cement as the unit, then the quantities in the "cement" column of the table must be reduced by 10 per cent. to obtain the number of barrels required per cubic yard of mortar.

Cement is sometimes shipped in bulk, in which case it is most convenient to measure the cement loose. The right-hand side of the table is then to be employed in making estimates. The quantities of cement in this side of the table can be translated into barrels by remembering that net weight per barrel of cement is about as follows, varying somewhat with manufactures, size of barrels, fineness, etc.:—Portland, 375 lbs.; Eastern Rosendale, 300 lbs.; Western Rosendale, 265 lbs.

Cement is also sometimes shipped in bags. Frequently the bags contain an aliquot part of a barrel, in which case either side of the table may be used, according to the method to be employed in mixing the cement and sand. Sometimes the bags contain an even number of hundred-weight, in which case the right-hand side of the table is most convenient.

TABLE FOR ESTIMATING QUANTITIES FOR MORTAR.

Composition of the mortar by volumes.		Cement and sand required to produce 1 cu. yd. of mortar.				
		If the composition is 1 volume of *packed* cement to — volume of loose sand.		If the composition is 1 volume of *loose* cement to — volumes of loose sand.		
				Cement, *lbs.*		
Cement	Sand	Cem't, *bbl.*	Sand cu. yd.	Portland.	Rosendale.	Sand, *cu. yd.*
1	0	7.14	0.00	2675	2140	0.00
1	1	4.16	0.58	1440	1150	0.67
1	2	2.85	0.80	990	720	0.84
1	3	2.00	0.90	675	540	0.94
1	4	1.70	0.95	525	420	0.98
1	5	1.25	0.97	425	340	0.99
1	6	1.14	0.98	355	285	1.00

COST OF MORTARS.—It is frequently a question as to whether Portland or Rosendale cement is more economical; this is a question of relative strengths and relative prices. The diagrams of Fig. 3 show the relative strength at different ages of Rosendale and Portland mortars of varying proportions of cement and sand.

To illustrate the method of using these diagrams, let it be assumed that a mortar is desired which shall have a strength of 90 to 100 lbs. at the end of a week. What composition shall the mortar have? and which cement is the cheaper? By the upper left-hand diagram, Fig. 3, it is seen that a clear Rosendale and also a 1 to 3 Portland mortar possesses the requisite strength. The cost of a cubic yard of each, if it be assumed that both the cement and sand are measured loose, *i. e.*, if we used the right-hand side of the table, will be about as follows:—

Rosendale, neat.

Cement, 2140 lbs., or 7.14 bbls. @ $1.00 =	$7.14
Labor =	.50
Total cost =	$7.64

Portland, 1 to 3.

Cement, 675 lbs., or 1.8 bbls. @ $3.00 =	$5.40
Sand, 0.94 yd. @ 0.40 =	.37
Labor =	.50
Total cost =	$6.27

Again, at the end of one year a 1 to 2 Rosendale mortar is equal in strength to a 1 to 4 Portland mortar. The cost of these mortars is as follows:—

Rosendale, 1 to 2.

Cement, 720 lbs., or 2.40 bbls. @ $1.00 =	$2.40
Sand, 0.84 cu yd. @ .40 =	.33
Labor =	.50
Total cost =	$3.23

‡ Reid's Treatise on Concrete, p. 65.

* E. C. Clarke, in Trans. Am. Soc. of C. E., Vol. 14, p. 150.

§ Mainly from Gillmore's and Grant's on Rosendale and Portland respectively.

Portland, 1 to 4.

Cement, 525 lbs., or 1.4 bbls. @ $3.00 =	$4.20
Sand, 0.98 cu. yd. @ .40 =	.40
Labor =	.50
Total cost =	$5.10

If, in the mixing, the cement be measured in its compacted state, *i.e.*, if the left-hand side of the table be used, the cost in the above examples will be $7.64 and $6.86, and $3.67 and $5.98 respectively.

When a very cheap mortar is desired, it is customary to use cement with a large dose of sand; this is objectionable, since the resulting mortar is very porous and consequently disintegrates rapidly. It is better to add common lime to the cement rather than to increase greatly the quantity of sand. This is then a question of relative strength and relative cost, and sometimes also of relative activity. Fig. 1 shows the strength of various mortars with varying proportions of cement and lime, from which the strength of any proposed combination can be determined; the amount of the several ingredients required can be determined by the data from which the cost can be easily computed. Gen. GILLMORE frequently urges the economy of mixing lime paste with cement mortar.

Mining Engineering.

BY JOHN L. CULLEY, C. E., CLEVELAND, O.

This paper, involving the general principles of mining engineering, pertains particularly to coal bank work as pursued in Ohio.

The objects of a mine survey are primarily to determine the mine alignment and elevations, estimates of the amount of coal mined within a given period, and the reproduction on the surface of the mine lines. This last, to ascertain if the company is operating within its bounds, or to determine its encroachments and the amount thereof upon its neighbors, is generally the paramount aim. Such surveys, as a rule, are made at wide intervals—just so far apart as in their opinions the proprietors can get along without them.

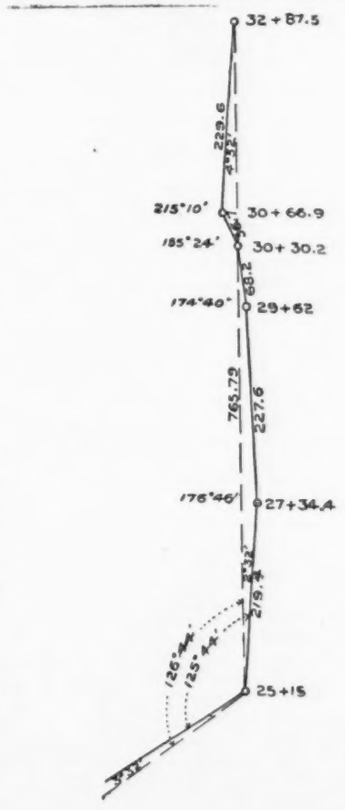
From an economical point of view alone this is a mistake—the mine and surface survey points become lost; the whole territory has to be gone over at each survey. As a result to all concerned, there is a mental uncertainty from the conflicting findings, where the true location should be. They should employ an engineer in whom they have confidence, and have their property surveyed at regular intervals of not less than one year each. In a short time this engineer will thus obtain absolutely true location of that portion of the lines common to all his surveys, as, for instance, that of the main entry. When so determined this location becomes the base line of all future surveys, whilst the proprietors will then reap the benefits of a continuous survey at less expense than by the former policy.

With the transit at the opening as long a line as possible is run into the main entry. Then without disturbing the instrument this line of convenient length is permanently located on the outside surface. The instrument is then moved to the mine foresight, back-sight taken on the first instrument point, a second course run and its deflection from the former course noted. This process is repeated throughout the entire survey, the courses being measured and objects, as butt, face and cross-entries, etc., located as the survey proceeds. Lamp flames are used for forward and back sights, also to read the instrument graduations and illuminate the cross-hairs. Instrument points are permanently located by nails in plugs driven into the roof and references taken thereto. The mine lines determined, the party proceeds to the surface, whence, with the portion of the first course already located, the several mine lines are projected on the surface. Such in brief is the process of a mine survey, the details of which it is now proposed to discuss.

The darkness of the mine renders everything so different from surface operations that, at first, the novice feels a painful uncertainty in his every movement. Particularly will he find it difficult to range, or bring the foresight into the instrument field; not unfrequently will this accomplishment put him to his wits ends. Having at last found the sight-line, he is still at sea to find the cross-hairs, or to bring them into the light. Practice in working in the dark, of course, dispels these troubles, yet they are never the simple thing they are in surface work. You will soon distinguish the cross-hairs on a light at 100 ft., as readily as in the open air, but to the experienced eye there is always a grave uncertainty in distinguishing the hairs on a light 400 or 500 ft. away.

These two obstacles to mine surveys are overcome by simple devices (1) *Alignment.* Use two brass sights, like those on the old compass, but only 1½ in. long, one at either end of the telescope. When they range the foresight, clamp the instrument, and by raising or lowering the telescope the light will be in the field. You may not be fortunate in having an instrument so mounted. Then make a V of wire or other light material 2 ins. long, place a rubber band around the object glass mounting, invert the V and insert its legs into the band on either side of the object glass by a double turn of the band around the leg ends. Now sight over the telescope barrel with the eye at the eye piece, bring the V vertex in line with the eye and foresight and then proceed as above with the brass sights.

2. *Cross-Hairs.*—Constantly illuminated in the

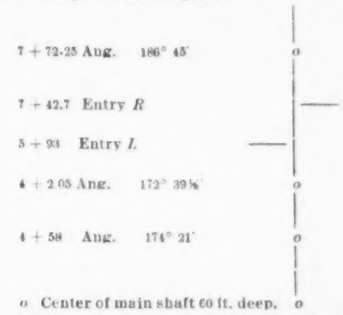


open air, cross-hairs are of course seen at all times, if illuminated in the mine they will be as readily seen. Place an ordinary white card over one-third of the object glass in a vertical plane at 45° inclination to the telescope axis against the object glass mounting; then a lamp flame 2 ins. from the telescope, on the opposite side to the card, and in the plane of the object glass will throw the light into the instrument and illuminate the cross hairs, be they spider web or otherwise. The opinion of others to the contrary notwithstanding, mine surveys can be made as readily with spider as with platinum wires. In this simple operation you place the card in position whilst an attendent adjusts the flame.

An engineer should never be required to touch a lamp during the survey. He should be supplied with an assistant for this purpose who soon learns your movements and always has the light where you want it. And it may be remarked that the ordinary miner's lamp is all that is required for a survey—the fancy contrivances of instrument makers are useless extravagances.

I find the Gurley patented extension tripod admirably adapted to mine work; good for inside and outside work, it is readily adjusted to the inequalities of the mine floor.

In measuring a mine it is wise to make the measurements continuous, as in railroad work, from beginning to end, taking plusses to all points of reference, and require the chainmen each to repeat the number of every station, and on the return of the party to the surface to remeasure the whole line and check off the plusses. Every 100-ft. mark should be chalked on the track, rail or other surface, and the number of every 5th station chalked on the roof. In place of noting that the angle of a course is to the left (*A. L.*), or to the right (*A. R.*), from the former course, it will be found much more simple to turn off angles always to the right. This will remove the uncertainty whether they were *A. L.* or *A. R.* Thus your notes might be



To check angle observations they should always be repeated. Magnetic bearings, however useful on the surface as checks upon angle reading, are of but little use in mine work, especially so if the usual railroad track is under your line. The author recently noted a difference of 10° in the inside and outside bearings of a course that was unaffected by the iron rails.

On account of the many sources of error: darkness, steep grades, changes of alignment, etc., every resort should be used to insure accuracy. To this end the angles of steep grades should be observed and the grades corrected to true horizontal lengths. The lines should be measured with steel tapes. The sulphuric acid of mine water, which freely attacks tape, is readily removed by diluted muriatic acid, and the muriatic acid in turn by a liberal application of well water. This prescription is excellent for the removal of ordinary steel tape rust. As proved by many years test, Roe's nickle plated band chain is proof against the mine sulphuric acid. It is therefore quite the thing for mine surveys.

A mine being unlike a city street liable to be measured every month or week, it is important that its survey points be most permanently marked, so that they will be readily recognized a year or so hence. They are best located in the roof, by driving wooden plugs in drill holes in it, and a nail in the plug at the exact point. To do this during the progress of the survey would consume valuable time. As each point is selected it can be transferred to the roof, and designated by a white chalk cross with a circle drawn around it. The plugs and nails can be put in after the completion of the survey. The points should be so referenced as to be easily found. A liberal supply of white lead around a point would be a useful guide. White chalk marks on the roof may be identified several years afterwards.

The conception of the average mine operator is that a 2 in. auger hole gives a sufficient base from which to locate with absolute certainty lines 4,000 ft. long. Where the mine has a slope entrance the problem of the surface survey is a comparatively simple one; with a shaft, under the most favorable circumstances, it is one full of uncertainties; especially is this so if the shaft is a deep one and the lines are of considerable magnitude. Thus if the shaft is 6 ft. in the clear, an error of ¼ inch would be enough to throw the survey "out of whack" 12½ ft. at a distance of 3000 ft. from the shaft. It is apparent that if there is any other opening it would be worth any effort to utilize it and extend the base. An air shaft 400 ft. away would render the final error inappreciable. Unfortunately the poor engineer is often left with a single shaft to solve the intricate problem of locating a line at the mine opening that shall be absolutely in the vertical plane of the first mine course. The common practice is to plumb the shaft. When this method is resorted to, well turned plumb bobs, weighing from 2 to 4 lbs. each, suspended by fine steel wire from the tipple roof should be used. To remove their vibrations the

bobs should be immersed in water. Then placing the transit in the line of the two plumb lines, test the vertical plane of the nearest wire. If right remove it and test the second wire. When the two wires coincide and are in a true vertical plane proceed with the surface survey.

It is the custom of engineers in this section, where the surface survey is over steep slopes, to measure the slope, observe its angle and reduce therefrom the horizontal distance. This is not warranted for practical reasons. The slope is rarely continuous and such measurement will answer only for the roughest kind of work, or as a check on the horizontal measurement. Its object is a saving of time and reduction of field work. Herein it is a signal failure. In a slope of 400 ft. it will take you twice as long to measure the distance and angle, and calculate the horizontal quantity, as it would to plumb up the whole distance. Moreover it is usually necessary to move your instrument to the top of the slope while the chainmen are measuring it, and their work will be performed long before you are again set up. You also avoid the necessity of calculating the distance, or another source of error.

Whenever that portion of the line common to all subsequent surveys has been established beyond a question, it should be so permanently located inside and outside the mine as to avoid the necessity of a resurvey.

The ultimate object of the surface survey is generally the location of the extreme mine workings and the direction of the last entry course. Now the entries of a given class have the same general direction. It is therefore easy to compute the air line of an entry from end to end. Thus in the accompanying sketch a face entry turns off at 25+15 and extends to 32+87.50, its air line is 765.79 ft. long. In the same manner the air line of the main entry to 25+15, and its angle with the first and last courses, is obtained as well as the angle 126° 44′ of these two air lines. This method will be found to facilitate the surface work, it avoids the constant set up of the instrument, and gives long base lines to operate from, for platting and for corrections of the entry alignments. These calculations should be made with great care, and of course in the office.

The Proposed Locks of the Panama Canal.

As promised in its last issue, *Le Genie Civil*, of Feb. 18, contains a description of the proposed locks for the Panama Canal, which we give in abstract as follows:

In the design of these locks, the canal is considered as being in process of construction, the deepening is to be continued so that by the successive removal of the levels the canal will finally reach the sea level. Four locks, two of 8 m. and two of 11 m. lift will reach the elevation of 38 m. from Colon on the Atlantic side. Four other locks, three of 11 m. and one of 8 m. will reach the altitude of 41 m. measured from the Pacific, at Panama.

The locks designed by M. EIFFEL, will be 18×180 m. (59×590½ ft.). In a great canal like the Panama, the use of the old type of lock-gate with two wings or gates becomes inadmissable. These locks must be used at all hours of the day and night, with a great lift, and consequent pressure; and to utilize the old form at all, the lift would have to be divided into a number of smaller lifts, an expedient adopted at the eight successive locks of the "Neptune's Stairway" on the Caledonian canal, and the seven locks at Beziers on the Canal du Midi. These subdivided locks, while easy to work, require an endless manipulation of parts and a consumption of time, that would be inadmissible upon a ship canal with great traffic.

Under these conditions M. EIFFEL has substituted for them a system of moveable caissons suspended at the upper portion. If we imagine a great ship accidentally grounded across a canal of width equal to the ships length we have the principle of the caisson lock-gate. Their application is recent, dating from about 1870 in its actual practice; while the common form of double-gate is as old as the time of LEONARDO DA VINCI.

The Panama system, as worked out by M. EIFFEL and M. PH. BUNAU-VARILLA, is generally shown in Fig. 1, with the gate shut. As there shown the caisson moves into a lateral chamber, and rolls upon tracks in the swing-bridge crossing the canal and other tracks over the lateral chamber, very much after the fashion of a common roller door seen about factories, etc. As soon as the caisson is housed the swing-bridge is turned until it is parallel with the axis of the canal and the path is clear for the ship.

The moveable caisson has tight sides strengthened at every metre of its height by strong horizontal beams of T-form. The lower part of the caisson is arranged very much like the working chamber of a pneumatic caisson used for foundation work. Above this working chamber it is divided into nine tight compartments by three horizontal and three vertical partitions. All of these compartments, as

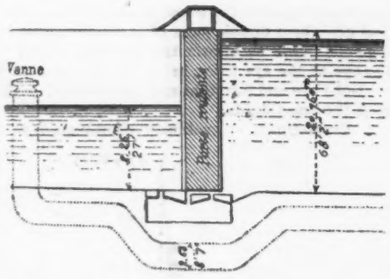


Fig. 2 Plan for Filling and Emptying Lock.

well as the bottom chamber, are so arranged as to be put in communication with the outer air by means of air-locks, so that they can be filled with compressed air or water at will. By this arrangement it will be easy to lighten the gates for easier working, or to bring them into equilibrium, and to visit and repair any interior defects, and also to remove any accumulations on the bottom which might interfere with the movement of the caisson.

The caisson is suspended by rods fixed to a wheeled truck rolling on the tracks before mentioned, with the advantage of having all this part of the mechanism above water and in plain view.

The general dimensions of a lock of 11 m. (36.08 ft.) lift are as follows:

Down-stream Gate.

Height	21 m. or 69.88 ft.
Width	4 m. or 13.12 ft.
Length	21.6 m. or 70.85 ft.

Up-stream Gate.

Height	10 m. or 32.80 ft.
Width	3 m. or 9.84 ft.
Length	21.6 m. or 70.85 ft.

For the 8 m. lock, or 26.24 ft. lift, the height alone varies, the other dimensions remaining practically the same. The free section of the canal left by the opening of a gate is 18.6 m. (61 ft.) at the bottom and 20.6 m. (67.5 ft.) at the surface level.

Fortunately each lock is so located that it will be excavated in the solid rock, with slight masonry protection in the more shattered rock. The side walls of the locks will be made of iron caissons with cast-iron bracing and the interior will be filled with beton. The dimensions of these caissons will vary with the size of the locks; for one of 11 m. lift these caissons would be 5.5 m. (18 ft.) thick, 24.25 m. (79.5 ft.) high and 30 m. (98.4 ft.) long.

The caisson gates and the swing-bridges will be operated by chains running over guide-rollers and worked by hydraulic power provided by turbines and the fall of the lock itself. They can also be worked by hand in case of an emergency or accident to the machinery.

To introduce into the lock so considerable a mass of water as 40,000 cu. m. (14,120,000 cu. ft.) in 15 minutes, requires special arrangements. The system adopted by M. EIFFEL to meet the peculiar conditions at Panama, is here first applied to any similar lock. His plan is to fill the lock throughout its entire length by vertical jets, in such a manner as to avoid the violent waves and general turbulence which would be inevitable without this disposition. For this purpose two cast-iron mains 2.8 m. (9.184 ft.) in diameter pass under the entire length of the lock; these pipes are pierced at intervals of 2 m. (6.56 ft.), and staggered in the length of the pipes, with holes .4 m. (1.3 ft.) in diameter. These pipes pass under the gate-sills at each end, and are prolonged to points about 50 ft. beyond the down stream gate and 40 ft. beyond the up-stream gate, as shown in Fig. 2. At these terminal points the pipes are deflected towards the side-walls of the lock entrance and inside these walls they ascend vertically to a height of 9.75 m. (32 ft.) above the platform level where they terminate in a sluice-way, provided with valves opening into the canal.

It is estimated that the construction of these works will consume about 15,000 tons of wrought-iron and 20,000 tons of cast-iron, all of which is to be of French manufacture according to the contract between the Company and M. EIFFEL.

The Plane-Table.

At the ordinary meeting of the Institution of Civil Engineers, on Tuesday, the 14th of February, the President, Mr. BRUCE, in the chair, a paper was read on "The Economic Use of the Plane-Table in Topographical Surveying," by Mr. JOSIAH PIERCE, Jun., M.A., Assoc. M. Inst. C.E.

The author stated that the plane-table, being one of the most ancient of surveying instruments, needed no introduction. However, he desired to direct attention to its wide and economical use on nearly all Government surveys, and to the fact that experience had proved that, within certain practical limits, plane-tabling was the most rapid, accurate, and economical method of executing topographical work. The modern plane-table, when properly constructed, was an altazimuth instrument of precision; with it the horizontal projections of existing angles were recorded graphically, free from errors of record, adjustment and plotting. The problem of plane-tabling was, simply: given a board and a ruler, construct a map. The most important geometrical laws applied in practice were those of similar figures. Three or more points being joined on the map, the requirement was that the figure thus produced should be the horizontal projection of the lines joining similar points in nature. Also, if lines were drawn from any other point joining the points of this polygon, a similar point should exist in nature where the observed angles would be exactly the same. This important condition was theoretically fulfilled when homologous sides in the two figures were parallel. To prove the necessity of placing the plane-table "in meridian" at all stations, the problem of orienting by three known points was demonstrated mechanically, and a working model was exhibited to illustrate all cases of the three-point problem. When a triangulation existed of the country to be mapped, a projection was laid down on the plane-table sheet, on a given scale, of the network of triangles, provision being made for the convergence of the meridians by suitable projection.

In American practice the trigonometrical system thus projected was tested and corrected graphically before being accepted as a sufficiently accurate base for the detail. Radial lines to salient points were drawn, with corresponding vertical angles in all directions from the stations occupied. The intersection of two rays on the same point being an elementary location, a third ray through the same point in a well-conditioned intersection placed beyond doubt the accuracy of its position. Thus, in the operation of plane-tabling, constant opportunities occurred of checking locations without calculation, and the scale was ever present in all directions to control the amount of detail to be gathered; in addition, a complete record of the area surveyed appeared, advantages which were to be found in no other system of mapping. When the scale of map was large, minute details could be more profitably located by the stadia-rod in horizontal position and altitude with surprising accuracy and rapidity. Whether by method of intersection alone, or combined with linear measurement, the operations were continued until a sufficient number of points had been located to satisfy the requirements of the map, beyond which it was purely an artistic sketch. Between the points located in altitude, as well as in position, equal-interval contours were interpolated, drawn and corrected from nature; this system was almost universally applied, and was especially valuable in mountainous regions. An unavoidable source of error peculiar to the instrument was the atmospheric or hygrometric effect on the paper or instrument used. In the United States a favorable climate had added not a little to the success of the methods pursued. The requirements of a plane-table of precision were the same as those of any other

type of altazimuth surveying instrument. By comparison of a number of types, the maximum stability and portability appeared in the United States Coast and Geodetic Survey pattern, and for mountain service a simple and efficient instrument, recently adopted by the United States Geological Survey, deserved examination.

The theoretical requirements in setting a plane-table over a station were: 1. That the plane of the board should be horizontal. 2. That the station on the map should be vertically over the point on the ground. 3. That the meridian of the point on the plane-table sheet should be in the plane of the meridian of the station. Of these requirements the first was met by proper construction, the third by adjustment in azimuth. To meet the second—the adjustment for eccentricity—numerous mechanical contrivances had been designed, of no practical value, and only lending additional weight and increasing the liability of error. The plane-table was not well adapted for traversing, owing to the difficulty of eliminating the eccentricity, which produced serious azimuth errors at short range; but by the error could be confined to one of geographical position, inappreciable on any common scale.

To secure the accurate results in plane-tabling, it was necessary to confine azimuth errors to minute quantities, not exceeding 1 in. or 2 ins., which would pass unobserved within the limits of the plane-table sheet. This degree of precision could only be secured by proper construction of the levelling movement and alidade. An examination of the sources of error, in measuring azimuth angles with a theodolite or plane-table, showed that the most serious source of error arose from an inclination of the transverse axis which supported the telescope. With an alidade in proper adjustment, practically the same errors would be produced if it was used on a plane-table not properly levelled. The effect of the board being out of level, and the telescope confined to a horizontal plane, was that the rule and telescope would only indicate the same direction at four points, which case was illustrated mechanically by Hooke's joint. In such a case the board might be out of level 15 deg. before the maximum error in azimuth would amount to 1 deg., which showed that a ough reconnaissance plane-table should give good results in a flat country; but for mountainous regions an accurate levelling movement was required.

For measuring altitude angles the alidade designed by Professor Hilgard was most accurate. Recent results and improvements showed, beyond doubt, that a far greater degree of precision could be obtained from simple graphic triangulation than was commonly supposed, amply sufficient for purposes of mapping, and with a degree of economy unequalled by other systems. The colonial engineer and student could ill afford to lose sight of a valuable and simple instrument, with which he could, alone and unaided, construct a topographical map on any scale with a degree of precision only limited by the scale, and in the same time that he would occupy in taking observations with other instruments. An appendix to the paper contained, among other matter, statistics gathered from official reports relating to the use of the plane-table, and an account of a plane-table survey of the Lake Mono region, illustrating the construction of an accurate map entirely on geometrical principles, without reference to scale or linear measurement.—*Engineering.*

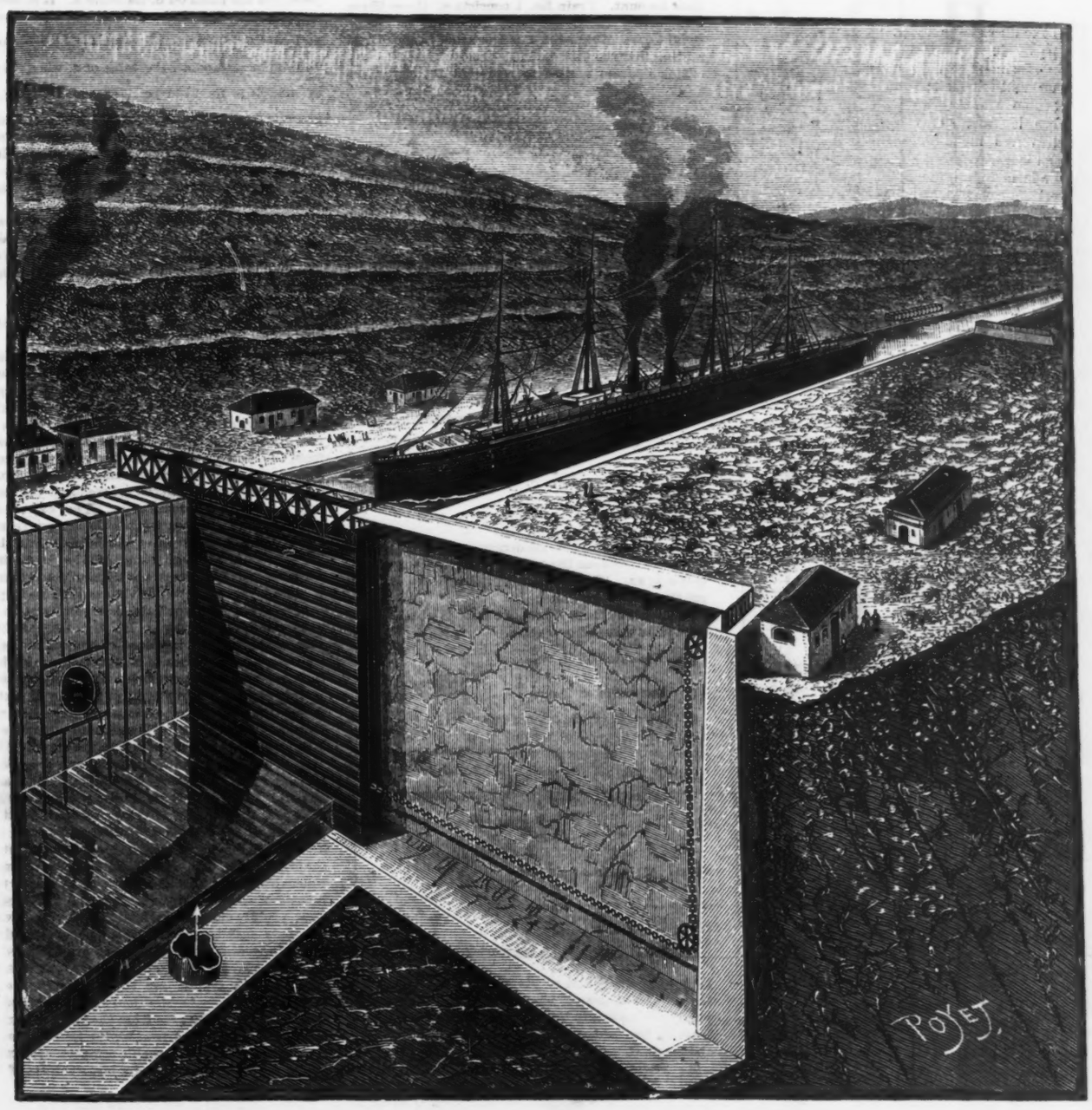
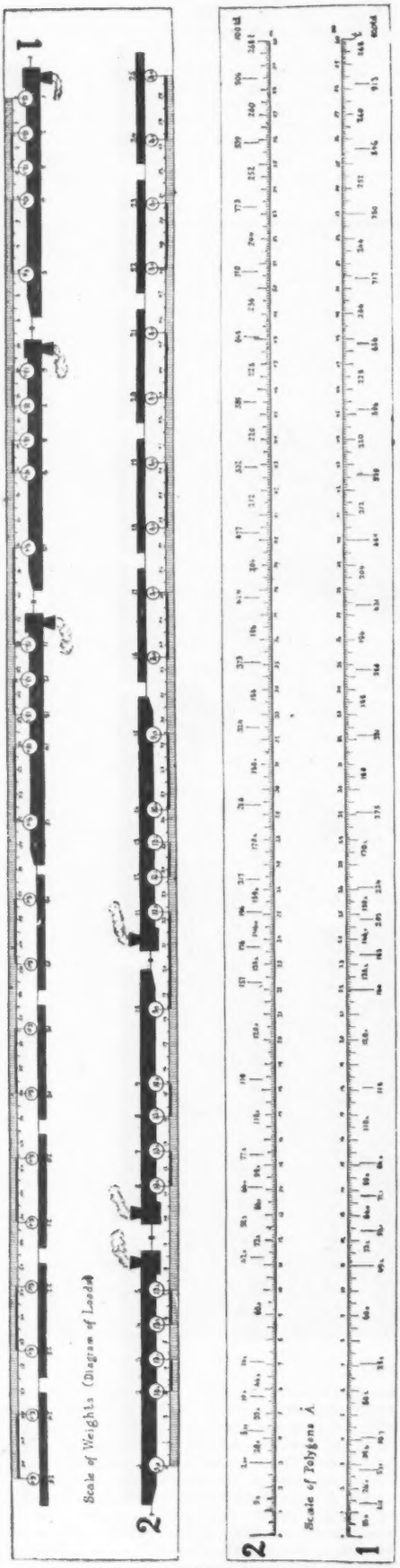


Fig. 1 The Proposed Balanced Caisson Lock-Gates for the Panama Canal.



Prof. Asimont's Load Diagram for Determining Stresses in Railway Bridges.

Load Diagram to Determine Stresses in Railway Bridges.

The following article and accompanying illustration is taken from a paper prepared by Prof. GOTTFRIED ASIMONT, of the Polytechnic School of Munich, and is translated for this journal by A. J. LESCHORN, M. E., with the Phœnix Bridge Company.

(1.) *Diagram of Loads.* Upon a scale divided into millimetres, the reactions and wheel loads are shown on a scale of 1 to 100. The diagram gives the distance of single wheel loads, their designation and their amount. Train No. 1 consists of three 60-ton locomotives (head forward) followed by 16-ton freight cars. Train No. 2 is the same as No. 1, excepting that the first engine is reversed.

This diagram is used to represent for any given

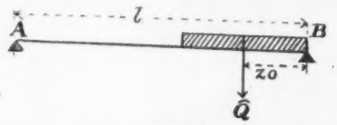


Fig. 1.

train length, z, the position of wheel loads upon the bridge.

(2.) *Scale of the Polygon A.* The trains are supposed to be moving from B towards A until the portion of the train z brought upon the bridge is equal; or its length from B equal to z.

If we suppose the distance of the center of gravity is z O, and its moment, $Q\ z\ o = a$, then a may be drawn as the ordinate of the abscissa z. The polygon A is thus obtained, commencing at the point B.

In the diagram a, the abscissas of the points of the polygon are noted, while the respective values of

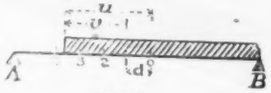


Fig. 2.

a are given in units of 100 decimeter tons. The figures noted between the vertical lines are the value, $Q = s\ a : s\ z$. With the aid of the scale we can now get the following values:—

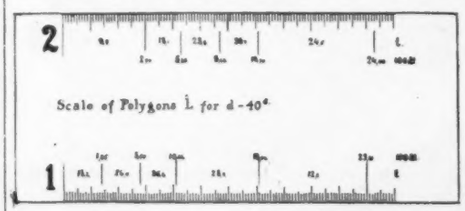
(1) The total load Q brought upon the bridge.

(2) The value of $a = Q\ z\ o$.

(3) The value of $A = \frac{a}{l}$.

(4) The value of $Z\ o = \frac{a}{Q}$

If the length of the train z exceeds by $s\ z$ the next smaller abscissa z_1, of a point of the polygon, it is necessary to interpose, as follows:—$a\ z = a\ z_1 + Q\ s\ z$, $s\ z$ being read off the scale. When the diagram of



loads is reversed and so placed upon the polygon a that the zero points of the two scales coincide, it is possible to ascertain the load which was the last to come on the bridge, and also its distance from the abutment B.

(3.) *Scale of Polygon L.* Suppose the length (Fig. 2) of span l to be divided into an equal number (δ) of equal panels d, and the train load Q to be so placed that the distance of the first wheel load from the panel point $0 = u$, and its distance from the next panel point $1 = v$; also calling a^0 and a^1 respectively the ordinates of the a polygons beginning in the panel points 0 and 1. Then the sum of all the concentrated loads to the left of O are:—

$$L = K_0 + K_1 + K_2 + \ldots = \frac{L}{a} = \delta\ \frac{L}{l}$$

$$L = a^0{}_u\ a^1{}_v$$

It will be seen that the value L, for the panel 0—1, may thus be formed for any given position of the train, but only for a certain panel length d; and likewise the value $V = A - L$. Whenever necessary interpolation may be resorted to. Some of the points of the polygon L will be found to be convex, others concave; the values *max. V* occurring at the concave points. The convex points may therefore be omitted.

The polygon thus abbreviated, *i. e.* containing only the concave points, is shown in Div. 2 on the diagram. The figures on the vertical lines represent the values of L in units of 100 decimeter-tons; those between the vertical lines show the values $s\ L : s\ z$, in tons.

To find max V for a number of panels δ.—To do this the above figures must be multiplied by δ and the zero point of the L scale placed upon the panel point 0 of the panel 0-1 of the scale a. It is now only necessary to proceed upon the scale L until the first vertical line is reached at which $\delta\ \frac{s\ L}{d\ z} > \frac{s\ a}{s\ z}$, and so read off or interpolate the value of a, when the value of *max V* is found to be $\frac{1}{l}(a - \delta\ L)$. The polygon a is dependent only upon the succession of the wheel loads, while the polygon L must be constructed separately for every new panel length d. In the present scale d is assumed to be 40 decimeters. For every number of panels δ the figures in the diagram should be multiplied by δ.

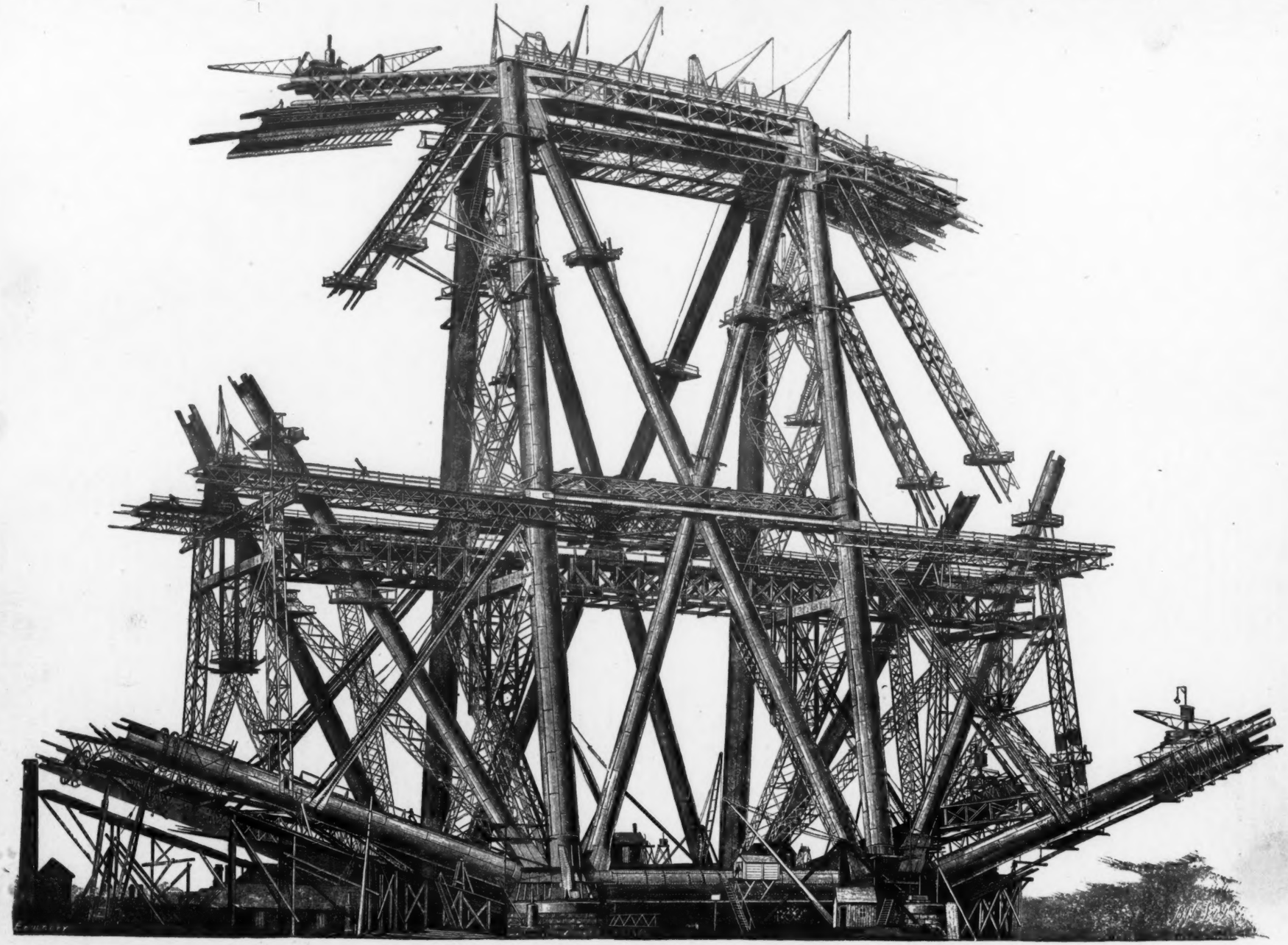
It should also be added, that the polygons a and L correctly drawn extend from the right towards the left. Upon the scales, however, they are laid down from left to right, an arrangement facilitating the use of the instrument.

A New System of Heating by Hot Air.

The office building at No. 24 State St., in this city, is heated by a system which is the invention of Mr. R. A. CHESEBROUGH, the owner of the building, and which has many points of merit. The especial disadvantages of a direct steam heating plant, aside from its original cost, are the annoying leakage from the radiator valves, the necessity of a considerable amount of superintendence and watchfulness over the boilers, connections, etc., and the lack of any provision for ventilation. The objections to hot air systems of heating are the danger from fire, the leakage of the gases of combustion into the hot air chamber through some of the joints in the furnace, and the excessive heating of the air, making it unduly dry and even in the cases where it passes over red hot iron surfaces, depriving it of a large proportion of oxygen. In Mr. CHESEBROUGH'S system the furnace is placed outside of the heating chamber and the gases of combustion are led into it through a masonry conduit. The heating surface in this chamber is in the form of a row of cast-iron domes set over the conduit which runs the whole length of the chamber. These domes are made with a lip at their base and are set in fire clay, and being free to expand and contract in any direction no leakage from loose joints is possible. The masonry chamber built over these domes receives air at its base, and the hot air is taken through sheet iron pipes from its top to the different rooms to be heated. A blower is used to force the air into the chamber, and this results in a large volume of warm air being distributed to the various rooms instead of a small volume of hot air. The air circulates rapidly enough without the blower, however, to supply sufficient heat, and the blower is only run in the daytime when the rooms are occupied and there is especial need of fresh air. The salient points of the system are the simple form of the heating surface whereby leakage is avoided, the separation of the furnace from the heating chamber, the use of heavy cast-iron for the heating surface, thus maintaining an equable temperature, and the forced draught for ensuring a large volume of fresh and warm air.

There is a novel piece of work in connection with the heating of this building. The tier of offices in the center of the building opens on an inclosed court with glass roof. This court is heated by the hot air system described above, and as the hallways opening from the court surround the rooms on their outer side, these rooms are practically enclosed in a body of air at uniform temperature, have no surface exposed to external radiation and have no need of any separate heater whatever.

This system may not be quite as economical of fuel as the best steam heating plants, and the space occupied by the heating chamber is considerable: but it is certainly very much cheaper in first cost and cost of maintenance than a steam



THE FIFE PIER OF THE FORTH BRIDGE.

SIR JOHN FOWLER AND MR. BENJAMIN BAKER, ENGINEERS.

heating plant, and will bear comparison even with the indirect system in point of comfort and health. For the warming of churches and halls where the plant is run intermittently, and its first cost forms a large proportion of the total expense of heating, it seems to be especially well adapted.

Reports of State Railroad Commissions.

IOWA.

The tenth annual report of the Board of Railroad Commissioners for the year ending June 30, 1887, is a fairly printed pamphlet of 127 pages. Between the two covers there is considerably more of valuable matter than in the reports of the average State Railway Commission. Messrs. DEY, COFFIN and SMITH, who constitute the board, have evidently made an honest effort to do their duty, and in doing it have expended a good deal of hard work.

The returns received from the railway companies occupy the last 50 pages of the report and have been most admirably arranged and digested. Most Commissions in their reports place each road by itself, making it practically impossible to compare the working of the different roads and draw those general conclusions without which the gathering of statistics is a useless task. In this report, table No. 1, entitled Capital Stock, gives for each road in the State, the stock paid in, amount per mile, amount of common and preferred, amount held in Iowa and amount of stock representing road not in Iowa. Other tables, of Debt, Cost, Earnings, Expenses, Interest and Dividends, Financial Condition of Companies, Condition of Road-Bed and Track, Mileage Traffic, Car Mileage, Equipment, Bridges, Crossings and Cattle Guards, Tonnage, etc., are equally full and accurate, and place the figures in so convenient a form that investors, or those who are interested in railway economics, can readily make use of them.

A separate report is made on matters of technical interest by Commissioner COFFIN, who recommends with strong arguments compulsory legislation in reference to the use of automatic couplers and continuous brakes for freight trains. He reviews the well known figures regarding the enormous loss of life and limb to trainmen from the link and pin coupler and the hand brakes. Then referring to the newly perfected Westinghouse brake, whose success has been so phenomenal, and to the adoption of a standard form of automatic coupler, he says:

"The application of the power brake to freight train service has been proved beyond all controversy to be not only eminently practical but an economical feature. There is no longer one particle of excuse for delay in this humane work of such legislation as will require railway companies to equip their freight cars with such brakes as will not necessitate the exposure of train men to the dangers and perils they have all these years so bravely met and so patiently endured. In the minds of railway managers the question of the economy and practicability of the power brake on freight cars is settled. It now remains for legislative action to reinforce the demands of these managers upon the Boards of Directors and stock owners for the means to place these power brakes upon freight cars.

"Along with and abreast of the brake has come the automatic coupler for these same freight cars. No one, however sanguine he might have been one year ago, would have dared to hope there would be made in the coming year such progress towards the adoption of a 'standard automatic coupler' for freight cars as has been made. To-day witnesses the grand fact that over two-thirds of the railroads of this nation stand pledged to the adoption of the 'Master Car-Builders' self-coupler of the Janney type.'

"Every objection to legislative action upon both of these indispensable safety appliances is now removed. The managers of the railroads themselves virtually come to the doors of our legislators and ask for such laws as will enable them to demand of railway Boards of Directors and stock owners, appropriations to enable them to fit up their cars with these safety appliances."

Legislation is also recommended restricting the running of Sunday trains, and the vexed subject of car famines is discussed from an impartial and sensible standpoint.

The legislation recommended by the whole commission is for the most part a repetition of the advice of former years, and includes the restriction of stock watering and creation of bonded indebtedness, a law making walking on railroad tracks a penal offense, prohibition of the carriage of dynamite and other explosives, the regulation of the construction of new roads by restricting the power to exercise the right of eminent domain, and repealing the law permitting a majority to vote a tax in aid of railway projects, and a law obliging all roads to fence their right-of-way.

In almost every case the commission seem to have realized that their duty is to act as an impartial tribunal, and if the legislators and voters of Iowa would read and follow the just and common sense advice which their Commissioners have given, instead of shouting for the proposed attempt to confiscate the railroad property in the state, it would be greatly to the credit of their honesty, fairness and good judgement.

MASSACHUSETTS.

The Nineteenth Annual Report of the Massachusetts State Railroad Commission is a volume of 313 pages, containing some fine illustrations printed by the heliotype process. A large and well printed map also accompanies the report, a feature without which no report of a State Railroad Commission can be considered complete. The last third of the report, like that of the Iowa board, is devoted to tabular statements compiled from the reports of the roads and is even fuller and more satisfactory than the Iowa report.

As has always been the case with the Massachusetts Commission, technical matters are discussed much more fully and soundly than in the average Railroad Commission's report. Considerable space is devoted to the subject of grade crossings. There are in the State 2,128 crossings of railways by public highways, of which 765 are protected by gates or flagmen. The total number killed or injured at these crossings during the year was 47, of which casualties 17, or nearly three-eighths, were at crossings protected by flagmen. There are also in the State a large number of private crossings. It is recommended that legislation be had empowering the railroad companies to do away with these, and also to provide for a division of the extra expense for over or under crossings where new highways are laid out. The conclusion is:

"Grade crossings on single track roads are dangerous; on double track roads they should seldom be permitted, on four tracks road, never. The multiplication of tracks, and the increasing number of fast freight and passenger express trains have driven this question of the abolition of grade crossings out of the domain of expediency into the domain of necessity."

The thorough overhauling and official inspection which was ordered immediately after the Forest Hills accident on all the railroad bridges of the State is described at length. The report of Prof. SWAIN, the engineer to the board, briefly reviews the progress which has been made on the work which has been undertaken, viz., collecting in the Commissioner's office complete drawings, strain sheets, specifications and data of construction of every bridge and track opening over 10 ft. in length in the State. The companies at once began the work of complying with this request but:

"Many of them, even some of the largest, had no plans or strain sheets whatever of the majority of their bridges, and their officials had no certain knowledge of the condition of said structures except such as would be gained by a superficial examination.

"The preparation of the strain sheets as required by the Board, has in some cases brought to light defects and cases of weakness which were entirely unsuspected, and this not on unimportant lines, but on some of the best managed roads in the State—roads on which it is the uniform endeavor to have everything in first-class condition, and where a bridge which was known to be unsafe or even doubtful, would not be allowed to remain for a single day."

"But the strain sheet alone is far from sufficient as a means of judging of the safety of a bridge, and in order to be assured of its condition it is absolutely necessary to have plans of every detail. * * * * * It is in the details and in the connections of the various parts that the principal defects are found, and the study of detail plans frequently reveals serious and even startling examples of bad design. Already in the examination of the plans submitted to your Board, cases of this kind have occurred, and one bridge, built but ten years ago and by one of the largest bridge companies in the country, has been discovered to be so faulty in its details that its immediate strengthening has been undertaken, and it will soon be replaced by a more substantial structure."

Guard rails and bridge floors are referred to, and it is stated that though a large amount of work has been done in accordance with the recommendations, the Board is by no means satisfied with their present condition as a whole. The collision post required by the laws of New York is thought to be an objectionable device. Train brakes and automatic couplers are briefly mentioned and their use is recommended. Car heating is taken up at length, but no definite recommendation is made regarding the adoption of any particular system. The results of this winter's experiments are awaited, and a further report on the subject is promised during the current month.

The appendix contains the special reports on the Bussey bridge and other accidents, letters from companies in answer to the circular letter regarding methods of car heating and other matter of interest. The report as a whole is deserving of commendation. Of course it is expected that Massachusetts, which was the first state to institute a modern railroad commission, will be at the front in devising methods of administration and control from which others may copy, and while there is sometimes reason to criticise the methods and recommendations of the Board, their work on the whole has been done faithfully and well.

The Fife Pier of the Forth Bridge.

(With Inset)

The view elsewhere reproduced from *The Engineer* shows the progress made on the Fife pier of the Forth bridge up to a few weeks ago. The other main piers are now in the same general condition of advance, differing from each other mainly in the greater or less projection of the main arch tubes and in the stays and braces erected with them.

The general dimensions of this structure have been often given, but to better appreciate the view presented, we may repeat that the top junction girders there shown are 362 ft. above the bridge datum. The north cantilever is out 170 ft. from the pier and about 130 ft. of the internal viaduct has been completed. Although the main arches are little more than begun, enough has been done to enable the engineer to form some idea of the immensity of detail in this maze of huge tubes and built-up members. The item of plant alone in platforms, cages, hoisting engines, riveting machines, etc., is perhaps the most costly and extensive ever gathered within the the same area for a similar piece of work.

ENGINEERING EWS.

THE vote on the pending amendments to the constitution of the American Society of Civil Engineers, canvassed March 7, stood as follows: amendments A being those raising the qualifications for the two present membership grades and adding a new grade of Student; amendment B providing for admitting foreign engineers on endorsement of the Board of Direction if not personally known to 5 members; amendment C providing for an open ballot in case of black-balled applicants if demanded by 8 members; and amendment D proposing to abolish altogether ballot by members, and entrust the election to the Board of Direction:

Whole number of ballots received	294
Unsigned or not entitled to vote	8
Total number counted and found correct	286

Amendment.	Yes.	No.	Not voting.	Total.
A	137	142	7	286
B	281	32	3	286
C	226	55	5	286
D	69	212	5	286

The passage of amendments B and C and the defeat of amendment D is in every way a fortunate result. Even the possibility of malicious black balling is now a thing of the past. Every man who is defeated on a first ballot may now, on the formal demand of 8 members, enjoy the constitutional privilege of being "confronted with his accusers," and cannot claim that he does not belong to the Society because he has two or three personal enemies within it. The defeat of amendment A is to be regretted; but even the strongest friends of the measure will the less regret it because it had been hastily amended into a form which made it to a large extent self-contradictory and absurd, as elsewhere noted. It will doubtless come up again next year in better form, and will then, we have no doubt, pass.

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AND

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EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Civil Engineers' Club of Cleveland, O.—Annual meeting, March 13. Secy., C. O. Arey, 31 Blackstone Building.

New England Water-Works Association.—Regular quarterly meeting, March 14, at Young's Hotel, Boston. "Biological Examination of Water," Wm. T. Sedgwick. Secy., R. C. P. Coggeshall, New Bedford, Mass.

New England Railroad Club.—Annual meeting March 14. "Wheels and Axles, and their Relation to the Track." Secy., Francis M. Curtis Boston & Albany R. R. Station, Boston, Mass.

Engineers' Club of Philadelphia, Pa.—Regular meeting, March 17. Secy., Howard Murphy 1122 Girard St.

Boston Society of Civil Engineers, Boston, Mass.—Annual meeting, March 21, at Young's Hotel, 4 P. M. Dinner at 6 P. M. Secy., S. E. Tinkham, City Hall.

Engineers' Club of St. Louis, Mo.—Regular meeting, March 21. "St. Louis Water Supply" W. B. Potter. Secy., W. H. Bryan, 709 Market St.

American Society of Civil Engineers, New York.—Regular meeting, March 21. Sec., John Bogart, 127 E. 23d St.

Engineers' Club of Kansas City, Mo.—Regular meeting, April 2. Secy., Kenneth Allen, 19 Deardorff Building.

American Water-Works Association.—Annual meeting at Cleveland, O., April 17, 18, 19. Secy. J. H. Decker, Hannibal, Mo.

American Society of Mechanical Engineers.—Meeting at Nashville, Tenn., in April or May. Secy., F. R. Hutton, 280 Broadway, New York City.

Master Car Builder's Association.—Next convention at Alexandria Bay, N. Y; commencing June 12. Secy., M. N. Forney, 45 Broadway, New York City.

American Railway Master Mechanics' Association.—Next meeting at the Thousand Islands, N. Y.; June 19. Secy., Angus Sinclair, Chicago.

Roadmasters' Association of America.—Next meeting at Washington, D. C. Sept. 11. Secy., H. W. Reed Waycross, Ga.

THE good opinion which every one has been acquiring of the Brotherhood of Locomotive Engineers has been sadly endangered by the course of events in the great C. B. & Q. strike. Whether that last resort be finally attempted or not, there has been an evident purpose among many of them to order a more or less general strike for the mere purpose of so paralyzing transportation as to enforce an agreement to their terms regardless of the merits of the dispute. The plain fact that this is a procedure precisely analogous to the "corners" in wheat, or any other necessary commodity which excite so much indignation, except indeed that it is worse, does not appear to occur to those who threaten the strike, but they will probably have early reason to appreciate it, should so foolish an attempt be made.

The worst that is attempted by a "corner" is to raise the price somewhat of certain necessities. Such a strike attempts to absolutely prohibit the sale to anyone of certain necessary labor, until certain individuals whom the public cannot control have complied to certain arbitrary demands. This is what the law already defines as conspiracy, and what it will define as such still more sharply and clearly, should necessity appear.

The truth is that modern civilization has become so complex, and differentiated that it may be most correctly likened to a vast machine, in which every man is a cog, and every industrial class a more or less important wheel. Some of these wheels, like the civil engineers, perhaps, can be dispensed with for a considerable time without throwing the whole machine into disorder, but there are dozens and hundreds of others, besides the locomotive engineers—such as washerwomen, cooks, milkmen, doctors, lawyers, butchers, bakers, gasmen, and what not—who cannot combine to suspend their labors as a body without producing general confusion and disaster, if they persist in the effort long enough. That more of these classes do not make similar attempts is due only to the fact (1) that they have not the intelligence to p rceive the apparent opportunity and persistently hang together, or (2) that they have too much intelligence to be deceived by the superficial possibilities into an attempt which is contrary both to good morals and good sense, and is hence foredoomed to failure. The locomotive engineers, and some analogous trade organizations occupy that unfortunate middle ground where they see the immediate chance but not the remoter conditions which make it a hopeless and improper one. Should such an attempt ever be pushed far enough to really rouse the community they will make short work of the offenders, for they will not long permit any person or any class to throw society into disorder in order to exact more pay for their services than the natural law of supply and demand will give them. There is another side to this question. Employers may attempt and do attempt to force down or keep down wages by precisely analogous means, counting on the inability of employés to suddenly and in large numbers change their avocations. But the present strike seems in no way to belong to this class, and therefore is, we believe, doomed to failure.

A CALL was recently issued for a meeting of the St. Louis members of the American Society of Civil Engineers "to discuss the advisability of having meetings of members of the Society residing in St. Louis and in the neighborhood, for the purpose of social intercourse and the discussion of such questions as may be brought before the members of the Society for vote." Similar action is contemplated, we understand, at Chicago and Milwaukee, if it has not already been taken. The immediate cause for this St. Louis call was supposed to be to discuss the pending amendments to the Constitution, the result of the vote on which is announced elsewhere, but as the Society grows larger it is inevitable that such action should be had at the larger cities, and if all society measures whatever could be thus discussed in advance, it would probably conduce greatly to wise action. Some ten or a dozen members responded to the call in St. Louis, and we have no doubt that more would do so if the meetings were made a regular institution. Whether this is a likely result or not must be doubtful. It would be a quite certain one, however, except that local organizations exist in all the large cities and subserve the same end, since most of the members of the American Society belong to them also.

THE total number of persons killed and injured by the New York *street* railways in the past two years, foots up to an aggregate which makes a surprising contrast with the safety of travel by steam power, being as follows:

	1886.	1887.
Killed	23	23
Injured	107	138

The ratio of killed to injured, which is only one to five or six, is proof positive that only the more serious injuries are reported, since experience has clearly shown that if all kinds of bodily injuries are called such, whether large or small, the proportion to deaths is much larger than that.

The population of New York City proper being about one-fiftieth of the whole population of the country, this proportion indicates that, if the whole population traveled by street cars as much as New Yorkers, there would be some 1,150 people per annum killed by them, and some five or six times as many seriously injured. The total number of people killed by steam railways is considerably larger than this, but of passengers only (a very different matter), not more than 1,200 or 1,300 per annum are killed, a fact indicating rudely but clearly that the danger of street car travel, which is ordinarily regarded as very safe, are not so vastly less than the dangers of ordinary railway travel, which few are disposed to speak lightly of.

The operating conditions are so dissimilar in street and steam railway traffic that any direct basis of comparison is difficult. Perhaps as fair a basis as any is by the total earnings. The gross earnings of all the New York street railways last year were $10,555,000, or nearly $460,000 per person killed, and about $65,000 per person killed or seriously injured, so that it would be necessary to expend a very considerable number of 5 cent fares before one's chances of accident were serious; but then the total earnings of the steam railways were nearly 84 times as much, or $882,192,000, so that they are entitled to kill about 1,930 and injure about 11,580 annually before they become as dangerous in proportion as street cars, on this basis of comparison. They actually kill and injure many more than this, beyond doubt, for the passengers killed and injured are only about a fifth or a sixth of the whole list, but not so many more as the enormously more perilous conditions would warrant, justifying the apparently absurd claim that in any kind of travel by rail the passenger is practically as safe as in his own house, and considerably safer than on the sidewalk and in the street.

It is to be regretted that there are no exact statistics by which it is possible to even approximately estimate the actual number of casualties due to the operation of railways in the whole United States. A tolerable approximation can be obtained by taking the aggregate of all the reported casualties in the States which require reports, and prorating the rest, but the result is so doubtful when obtained as to be hardly worth the trouble. There could be no more useful application of the powers of Congress to "regulate commerce between the States" than to provide for the collection of National railway and other transportation statistics in the thorough way that three or four of the States do, but on a uniform plan. The cost would not be great, while the value of such records would be very great. But it is probably too much to hope that anything of the kind will be done in our time, in a non-political intelligent fashion, and if not done well, it were better not done at all.

The comparative casualties of the Manhattan Elevated railway and the street railways are as follows:

	Killed.		Injured.		Total.		Revenue.
	1886	1887	1886	1887	Kil'd	Inj'd	both yrs
Manhattan elev.	8	19	55	66	27	122	$15,370,000
Street railways	23	23	107	138	46	245	19,861,000

The comparison here is very decidedly in favor of the elevated lines, despite the higher speed and the dangers to employés on the high tracks which account for a large part of their casualities. The elevated killed only one person for $570,000 of receipts, and killed or injured one for every $103,000, against $431,000 and $68,000 respectively on the surface street cars. In passengers only, had we the data at hand, we have no doubt the comparison would be still more in favor of the elevated, yet the majority of people feel perfectly safe in a street car and are more or less timid on the elevated.

THE advance in the load of freight cars in the last seven or eight years is doubtless rightly charged with the responsibility for many of the later freight wrecks. Within this period the loading capacity of a freight car has been advanced from 20,000 lbs. to 50,000 and even 60,000 lbs. When the car had been designed to carry this larger load it was all right. But when a car of the old type was loaded to twice and three times its originally rated capacity trouble followed. One of the overloaded cars may stand the strain put upon it for some time; but after awhile it gets into the middle of a long train; the truss settles under the continual jar: the old frame gives way, or an axle breaks and there is a wreck. The evil has become so pronounced that an organization was perfected in Buffalo last week which has for its purpose the close inspection and weighing of overloaded freight cars in the interest of the transportation companies.

THE defeat of the amendments reorganizing the grades of the American Society of Civil Engineers, and adding the new grade of Student by the nearly even vote of 137 ayes to 142 nays is chronicled elsewhere. To have passed there would have been required 186 ayes and 93 nays, since the constitution very properly requires a two-thirds vote in favor of any amendment for its passage. The result is, on the whole, greatly to be regretted, but the less so because there is probably no one who would have desired the amendments to retain permanently the form in which they were sent out for ballot, since they involved an evident absurdity in the form to which they were amended, viz.: an increase in the qualifications of the present Junior grade to nearly the point which is now required for full Member, and the addition of a lower grade below it, while still retaining the name Junior for the *intermediate* grade. The present grades of Member and Junior are at least logical, whether permanently desirable or not. The three grades of Member, Associate Member and Student, as originally proposed, were likewise logical; nor would it have been particularly objectionable to have changed the title of the lowest grade to Junior, which term would then have correctly defined its character. But the change of terms to Member, *Junior*, and Student, besides the absurdity noted, implied what was not at all the case, that the change proposed was merely the addition of another grade below that of Junior, whereas it might be more truly defined as a practical retention of the present lower grade, as it is, with lower dues and only a slight decrease in the age and other qualifications, and an increase in the qualifications for Member to a point high enough to admit and require an intermediate grade of Associate Member; to which grade only a large proportion of those who now come in as full Member would have been eligible.

This will be more generally understood should the amendments be offered again this year with certain correction of form, as we presume they will, and the amendments will then probably pass.

The passage by an almost unanimous vote of the amendment which forbids the permanent exclusion of any candidate by a secret black-ball is a great step in advance, and a necessary one if it is ever to come about that membership or non-membership in the National Society of Engineers is to be equivalent to being in or out of the profession, as is greatly to be desired. By the new amendment the form of the first ballot remains as now, but if a candidate be found defeated, any eight members in good standing may demand a reconsideration in his behalf, and the second ballot must be an open one. The number of negative votes required to exclude still remains five, but if the votes are to stand they must be signed or openly announced. It does not necessarily follow that they will be proclaimed upon the house-tops or embalmed in the printed records; the amendment is wisely silent on that point, but those who are really voting nay merely from personal enmity or prejudice will be unwilling to let *anyone* know that they do so, and as they must do this to have their vote stand, that is the candidate's sufficient protection.

Switchbacks, their Use and Construction.

Our correspondent, under the above head in another column raises a point in respect to the use of switchbacks as permanent features of mountain lines with relatively thin traffic, which it seems to us worth while to clear up with somewhat more fullness than can be appropriately done in a note to his letter; for the reason that such switchbacks are not as much used as it is desirable for many reasons that they should be. When used at all they are mostly on temporary lines, carelessly and wrongly laid out, to serve a more than temporary purpose; and are in this form justly regarded as an inadmissible feature for a permanent line. We cannot now take space to review the arguments which show that, properly laid out, with gradients similar to those shown in the cut which accompanies our correspondent's letter, they would furnish not only a cheaper but a better and safer way of making long ascents for lines, like most of the Rocky Mountain lines, which have really a very thin traffic. The reasons for this conclusion can be found in the volume to which our correspondent refers. We confine ourselves now to the special objection raised by him, that trains "laboring up hill," might be apt to stall at them.

A switchback is, from the necessities of the case, on comparatively heavy grades, and where speed even of passenger trains is slow; otherwise it would not be constructed. A train which has surplus power enough to run up the hill at speeds higher than 15 miles per hour can afford to throw away some of it by stopping with brakes or by running an unnecessary distance up the tail of the switchback, and, therefore, need not be considered. All that is necessary is that the switchback shall be entirely practicable for any speed *less* than 15 miles an hour. It will be then all right for any higher speed if the tail of the switchback be made long enough and steep enough to prevent a fast train running off of it.

The tractive power of a heavy Consolidation engine on various heavy grades is (Table 170 of the volume referred to), on a grade of

	1.5 p. c.	2 p. c.	3 p. c.	4 p. c.
Tons	552	420	273	193
Cars	18	14	9	6

from which it results that the total length of train will be about (37 ft. per car):

736 ft.	588 ft.	303 ft.	192 ft.

The trains are more likely to be shorter than longer than this, and if in part of empty cars will be proportionately lighter, as a rule.

The "velocity head" corresponding to various speeds is (Table 118):

Miles per hour.	Veloc. head ft.	Miles per hour.	Veloc. head ft.
1	0.04	8	2.27
2	0.14	9	2.88
3	0.32	10	3.55
4	0.57	11	4.30
5	0.89	12	5.11
6	1.28	13	6.00
7	1.74	14	6.96
		15	7.99

If a train be advancing up the grade with any *uniform* velocity given above it will be brought to rest when the *center of gravity* of the train has been lifted above the regular grade line by the above amounts. In the cut a train 500 ft. long has its center of gravity lifted about 5 ft. above the grade line, corresponding to a speed of about 12 miles per hour, if the train in the cut be assumed to be in the act of coming to rest before it returns again down grade.

Now, that train has been running perhaps 4 or 5 miles up hill, and in each mile has risen about 106 ft., or perhaps 500 or 600 ft. in all. How much more work will that engine have had to do to approach the headblock with a speed of 12 or 15 miles per hour instead of "laboring along" at the 6 or 8 miles per hour which our correspondent assumes?

Obviously, enough more to have lifted the train through the difference between the "velocity heads" due to 6 or 8 and to 12 or 15 miles per hour, which is

	M.p.h.	V.h'd	M.p.h.	V.h'd.	Diff.	
from	6	1.28	12	5.11	3.83	
	8	2.27	to 15	7.99	to 5.72	vertical feet.

In other words, the engine has to do somewhere on the preceding 4 or 5 miles about one per cent. more work in order to approach the switchback at 12 to 15 miles per hour instead of 6 or 8. If it were necessary this could be allowed for by a slight easing of the approach grade just below the switchback, and if the curvature is particularly sharp and severe in the immediate vicinity of the switchback this should be done, but otherwise it is not necessary, as thus:

The engine may be laboring on the grade either from a deficiency of steam power or from a deficiency of adhesion, or both. If it be the former, and it is only able to keep up 6 or 8 miles per hour, it is on the point of stalling any way, because the head due to those speeds is so small that it is liable at any time to drop to zero, and the speed is so slow as not to keep up a proper rate of combustion. The engine may as well stall in one place as another, but as it has only to lift the train about 2 ft. more vertically than that due to its velocity head in order to clear the switch, it can, by using sand for the preceding 500 ft., or so, pull past the head-block slowly by brute force, since it is only equivalent to pulling over a 2.4 per cent grade for that distance, and any engine which is not greatly overloaded for practical work on a *long* 2.0 per cent. grade, is equal to that additional work for a few stations; because it can actually work up to over ¼ adhesion by the use of sand, whereas no engine is loaded for over ¼ adhesion in daily work.

On the other hand, if the difficulty be from lack of adhesion, from bad condition of rails or otherwise, the case is still simpler. This cannot be remedied for the whole height of the hill by use of sand, but it can be so remedied for a short distance anywhere. The effect of sand upon adhesion seems to be merely to raise it up to a reliable, constant maximum of about ¼ in all conditions of rails. It does not materially, if at all, increase the adhesion on

a good rail in good weather, but it does suffice to make the state of the rail and weather a matter of indifference.

In other words, if the train is in any condition to make the run up the hill apart from the switchback, it is in at least as good a condition for passing the switchback, but a train which is *in fact* "laboring up hill at 6 or 8 miles per hour as the best it can do" is practically on the point of stalling anyway. Its chances of making any furthur long run are slim indeed, and hence that condition practically obtains much less frequently than is supposed. If the chance of its passing the switchback are *as good* as of passing any other point that is enough. What our correspondent seems in effect to contemplate, that the train shall in no case stall at the switchback whether it does anywhere else or not, is not a rational requirement, although it may be secured, if desired, without giving away elevation by the drop in grade suggested, by the simple expedient of dropping the switchback bodily 2 or 3 ft., lowering the rate of grade by so much just below the switchback and increasing it correspondingly just above. The same possibility exists at all points on the track. All we have to do to ensure that trains shall never stall at any one point, is to introduce a slight sag in our grade line there, recovering the original grade line beyond. The probability of stalling beyond is not increased thereby, within moderate limits; it remains constant; and by failing to rise again to the original grade line beyond we retain the advantage gained all the rest of the way up. The importance of doing this at the switchback is really no greater than at any other point of the track, but merely because there is a switchback there instead of a continuous ascent, there is a natural but mistaken disposition to insist on *extra* precaution against stalling there.

There cannot of course be any fixed rule for the precise arrangement of gradients at a switchback to obtain the best results. In some case the up-trains may be almost wholly empty cars, which will require room for proportionately longer trains, and the conditions may be such as to make it almost a certainty that the speed will be also abnormally slow just before reaching the switchback. In that case, the total lift of the center of gravity of the train, after its whole length has passed the switchback, may be only a foot which, any train moving at over 5 miles per hour can certainly make. The one rule is: Make the entrance *easy enough* to ensure the largest trains being able to enter it if not overloaded for the rest of the ascent, and then give the rest of the tail track an increasingly rapid rate of ascent, so as to ensure stopping a train moving at higher speed (up to about 15 miles per hour), by gravity only in but little longer distance. The motion over and through such a switchback will be as easy and as smooth as on a continuous ascent, with certain decided additional advantages in the way of safety, a great decrease in first cost, and a gain rather than loss in the total time of ascent, despite the stop.

Were it more generally appreciated that the ascent over such switchbacks was just as easy and just as quick as over a continuous ascent, and that the stop and reversal of motion involves no more loss of time and power than the stop of a pendulum under precisely analogous mechanical conditions, it would then be more generally seen that as a precaution against runaway trains alone such switchbacks are desirable, not to speak of the heavy decrease in grade and cost of construction which they will ordinarily render possible.

The Frauds in the Public Land Surveys.

One of the results of the present system of dividing up the public works carried on by the Government among a large number of departments and bureaus is becoming unpleasantly evident in some parts of Colorado. We refer to the frauds which have been practiced in the surveys of the public lands. There are doubtless plenty of localities on the prairies farther east, where the work of the Government surveyor was not done with the precision and thoroughness so highly desirable in the original location of political and property boundaries; but the work which has been done, or rather which has not been done, in the rougher regions of the Rocky Mountains is a public disgrace.

A dispatch from Pueblo, Col., to the Kansas City *Times* gives an account of the trouble and expense which settlers are encountering in that State. After his "improvement" is made on his land the settler goes to file his claim at the Land Office, but can find no description of the land. The field notes of that particular township may be wanting, or [a meaningless jumble. Finally he gets the notes from the Surveyor-General's office and starts out to find the "corners," but they are not there and never were. The field notes may read smoothly enough, describing a "mound of rocks, and on east side placed quartz rock 15 × 12 × 17 in. placed 8 in. into the ground, marked 111 on east side and 111 on south side," etc. Yet not even one stone laid on another can be found. In some cases it is evident that the public land surveys were laid out by reference to the railroads. The Government surveyors, obtaining the meanders of the railroad survey, gave descriptions of the sections, townships, and ranges by the aid of it, their actual survey being made from the top of a moving freight train, the map filled out by the sketches of HAYDEN'S explorers and the field notes made to read nicely by supplying ravines, gulches, and "old ruins," (a favorite landmark in such cases), so that they were readily accepted in the distant Surveyor-General's office, when backed up by the necessary affidavits.

In this connection we recall the experience of a surveyor acquaintance of ours, who secured a contract for dividing into sections a large area in Colorado where the township lines had already been run. He was an honest man as men go, and when he went to the rugged country where his work lay and found that all the notes and descriptions of the township surveys, which had been furnished him, were pure fiction, he toiled over mountains and chasms and ran the township lines accurately and correctly, and afterward made his sectional survey. When he sent in his report to the Surveyor-General's office he had some hope that the authorities would at least thank him for the extra work he had done for his country, and for calling attention to the unfortunate omission which the former surveyor had made. They did not thank him. They sent him a curt note informing him that the survey which he had contracted to make did not agree with the records in the office at Washington, and could not be accepted. Our surveyor friend paid the expenses of his summer's work from his own hard earned dollars, and registered a vow never to have aught to do with another Government survey.

If anyone doubts that the public land surveys all through the West are a notorious disgrace and the cause of an enormous amount of litigation, expense and public injury, let him turn to the back volumes of ENGINEERING NEWS and he will find plenty of testimony in the form of letters from surveyors who know whereof they speak.

It is sometimes said in opposition to the proposed consolidation of Government Public Works into a single department, that the various bureaus are all working efficiently and well and it is best to "let well enough alone." But it is clear that under a properly centralized administration of these vitally important departments of the Government, not only would the duplication and interference now so common be done away with, but frauds and errors in one bureau would be checked and exposed by another, and such shameful steals as those described above would be rendered far more difficult than under the present system.

The Mauch Chunk Suspension Bridge.

Mr. W. HILDEBRAND, the designer of the Mauch Chunk suspension bridge illustrated in our issue of Feb. 25, gives us the following points of difference between his bridge and the somewhat similar one at Freibourg described by Mr. JOHN C. TRAUTWINE, Jr., in our last issue:—Without being acquainted with further details of the Swiss bridge than he could obtain from a description of the small photograph, Mr. HILDEBRAND says that he believes the resemblance to be limited to the fact they are both half-spans, an expedient which in itself is not particularly new. He believes, however, that there is one principle in the Mauch Chunk structure which is novel as far as he has any knowledge. It will be noticed from the cut given that while the span between towers is 480 ft., the bridge floor is but 360 ft. long. According to the usual arrangement of suspension bridges the cable should be supported on a tower at the end of the bridge floor, and be anchored a short distance beyond the tower. Instead of this, in the American bridge, the cable has been extended, in the direction of its tangent, 120 ft. beyond the floor; the object being to avoid a rather high tower and to find more favorable ground for anchorage than existed below.

Theoretically the bridge ends at the same point as the floor, and vertically above this floor; but the cable has been fixed and made immoveable by a strong guy anchored to the rock. It will be seen that without this guy, which was adjusted during hot weather, a fall in temperature would make considerable mischief; either the thin suspenders near the upper end would break, or the floor would be torn loose and the pipe endangered. This guy, therefore is an essential feature of the construction, which according to the photograph was neither used nor needed at the Freibourg bridge.

Mr. HILDEBRAND also pointed out some other details of construction which differ from the usual methods, and if they too exist in the Swiss bridge the coincidence of independent ideas would indeed be remarkable. The first of these details is in the construction of the side railing or stiffening trusses of the bridge. The material used here consisted of two coils of $\frac{1}{2}$ in. and $\frac{3}{8}$ in. wire-rope and a bundle of $\frac{1}{4}$ in. rods 3 ft. 6 in. long with an eye at one end. These rods were located, eye-end up, on every alternate floor-beam, or 12 ft. apart, and lashed to the suspenders at these points by wire wrapping. The $\frac{1}{2}$ in. rope was then drawn through at the eyes and being fastened at each end of floor, forms the hand-rail; while stiffness was obtained by running a continuous line of $\frac{3}{8}$ in. rope diagonally through the eyes and under the floor beams, the two systems crossing between each pair of rods. The truss thus formed lacks a top-chord near the upper end of the floor, but the cables being flat and running for a long distance almost parallel with the floor form an efficient substitute near the center and lower end of the bridge. Where the cables pass under the floor and there were no suspenders to lash to, the railing posts were made of 1 in. iron and the lower end was forged into a clamp which tightly clapsed the cable. Incomplete as this truss appears, it does its duty well and the bridge is surprisingly stiff considering the light material used in its construction.

Another detail of note is the anchorage of the cables. The upper end of each cable is fastened in a socket of conical shape which rests between two eye-bars, and abuts against two flat pins in these eye-bars, with the cable passing between the pins. The lower ends of the cables were fastened into

stirrup sockets, with screw stirrups for adjustment. These sockets differ from those in ordinary use in having two lugs cast on them for the purpose of connecting the sockets with the anchor-pins by means of a wire wrapping. On two opposite faces of the coned block for securing the cable end are lugs for the stirrup; and on the other two faces of this block are spools in line with other spools on the anchor-pin; around these spools passes the wire wrapping. This arrangement relieves the strains on the stirrups, and forms a flexible joint without endangering the screw-ends of the rods.

PERSONAL.

M. E. INGALLS has been elected President of the Chesapeake & Ohio Ry. Co.

PETER HERDIC, inventor of the Herdic cab, and builder of the water-works at Huntington, Pa., died recently in New York.

J. CALDWELL, superintendent of the Cairo, Vincennes & Chicago Ry., has resigned. C. E. DOYLE will perform his duties.

C. D. MCLEOD has been appointed Superintendent of the Bellaire, Zanesville & Cincinnati R. R., with office at Zanesville, O.

J. H. DECKER, Superintendent of the water and gas works, Hannibal, Mo., has resigned. He will be succeeded by C. J. LEWIS, superintendent of the gas works, Joplin, Mo.

W. A. BALDWIN, Manager of the Pennsylvania Co., has resigned, to accept the position of General Manager and Vice President of the Buffalo, Rochester & Pittsburg Ry.

F. WOODBRIDGE, Assistant Chief Engineer of the Ohio, Indiana & Western Ry. has resigned to accept the position of Chief Engineer and Roadmaster of the Cleveland, Sandusky & Cincinnati R. R.

FRANK SNYDER, Civil and Hydraulic Engineer, of Columbus, O., has been engaged to prepare plans for a complete system of sewerage for Circleville, O.

JOHN GRAHAM, Vice President for the past 18 years of the National Meter Company, New York, died on the 12th inst. at his residence 354 W. 33rd St. New York, after an illness of 3 days.

W. H. BOYD has been appointed Superintendent of the division of the Missouri Pacific extending from Longview south to Galveston and west to Taylor. T. CRONIN is Roadmaster. Headquarters at Palestine, Tex.

In our issue of Dec. 24 we stated that SYLVANUS MILLER, Jr., who had just reported upon the Panama canal, "was not a Member of the Am. Soc. C. E." This was a mistake on our part, due to the fact that he had been elected *since* the publication of the last list of Members.

GEO. HILL & CO., New Brunswick, N. J. have opened an office in that city as Civil Engineers and Architects, but with a specialty of Topography. We are glad to note their enterprise. With a large practical experience in railroad location and topographic work, they are especially fitted to execute preliminary topographic work for sanitary and other engineers, thus leaving the latter free to accept more work, and only retaining in their office the men necessary for designing and superintending. It is another application of the division of labor, and undoubtedly the new firm will find a ready demand for their special talents.

THE New York, Ontario & Western Railroad is to shorten and improve its line over the divide between the Delaware and Susquehanna watersheds by the construction of a 1,500 ft. tunnel, work on which is to begin at once. This company is now under excellent management and its prosperity is accompanied by excellent work in the line of permanent improvements.

CORRESPONDENCE.

Fibre Strains in Pins.

Sheffield Scientific School of Yale College.
NEW HAVEN, CONN., March 3, 1888.

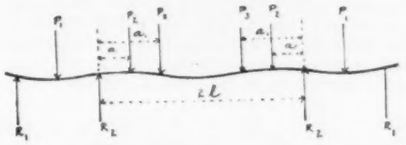
EDITOR ENGINEERING NEWS:

Mr. BUDDINGTON, in your issue of March 3rd, takes issue with Prof. JOHNSON and backs up Mr. COOPER. He refers to Prof. BURR and to myself as in error with Prof. JOHNSON, in "regarding, by implication at least, the stresses to which the pin is subjected as tending to curve the pin in one direction only; the pin is considered to be concave or convex its whole length."

Speaking for myself I wish most distinctly to state that no such implicit assumption is made, nor as I understand it, is any such assumption made by Prof. BURR or JOHNSON. Indeed in your issue of Feb. 4, Prof. JOHNSON has given the curve just as Mr. BUDDINGTON says it ought to be.

The simple principle which we all apply is that the moment at any point of a beam is equal to the algebraic sum of all the forces on the left or right. This principle holds, whether the beam be continuous or not, and as to convexity or concavity, that takes care of itself. No assumption whatever is made, or needs to be made as to that point.

Let us take Mr. BUDDINGTON'S diagram.



Call the distance of R_1 from P_1, x, and the distance of P_1 from R_2, y. Take rotation from left to right as positive.

Now I simply assert, and Profs. BURR and JOHNSON simply assert, that the moment at the point of application of P_3 will be $M = R_1 (x + y + a_1) - P_1 (y + a_1) + R_2 a_1 - P_2 (a_1 - a)$ (1)

Will Mr. BUDDINGTON deny this? Will Mr. COOPER deny it? If so, the question is closed so far as they are concerned. But I venture to say that no one capable of calculating the simplest structure will question this application of so familiar a principle. Now we can write (1) in the following form.

$M = + P_2 a - P_1 a_1 - P_2 a_1 + R_2 a_1 + R_1 a_1 + R_1 (x + y) - P_1 y$. But we also have from the conditions of the case

$$R_1 + R_2 = P_1 + P_2 + P_3$$

Hence at once by substitution

$$M = P_2 a + P_3 a_1 + R_1 (x + y) - P_1 y$$

If finally we put $M_1 = R_1 (x + y) - P_1 y$ (2)

we have

$$M = P_2 a + P_3 a_1 + M_1$$

This result differs from Mr. BUDDINGTON'S in only one small particular, but that is a very important one. His result is precisely the same, *except that he writes* $- M_1$ *instead of* $+ M_1$. This is just his error. If he will correct it, he will be in exact accord with Prof's. JOHNSON and BURR, and he will see at once that they really do take the beam just as he thinks they ought to. If he refuses to make this correction it will be in order for him to tell us why.

Now taking as he does, $a = 1''$, $a_1 = 2\frac{5}{8}''$, $P_2 = 30{,}250$ lbs. $P_3 = 30{,}650$ lbs., we have the maximum fibre stress

$$T = 67{,}000 + \frac{M_1}{1.53}$$

and *not* as Mr. BUDDINGTON gives it

$$T = 67{,}000 - \frac{M_1}{1.53}$$

Hence T may be considerably *greater* than 67,000 lbs. and *not* as Mr. BUDDINGTON concludes, considerably less.

Mathematics apart, Mr. Editor, is not this evident to any one who looks at the diagram? Will not the action of an upward force R_1, by itself, be to *increase* the fibre stresses due to P_2 P_3? The action of P_1 (a less force with a less lever arm), will be less in the opposite direction. The two together will then give a resultant *increase* of fibre stress.

A consideration of (2) shows at once that to "regard the center span as an independent girder" is an error *not* on the "side of safety." There is more not less tension in the lower and compression in the upper fiber by reason of the side spans, and the beam as a matter of fact *don't bend, as* Mr. BUDNIDGTON *has drawn it*, unless the moment $P_1 y$, is greater than $R_1 (x + y)$. But that as we have said, will in any special case take care of itself. There is no necessity to make assumptions about it. But this is precisely what Mr. BUDDINGTON does, when he writes—M_1. Without knowing x or y_1, P_1 or R_1, he implicitly assumes $P_1 y$ greater than $R_1 (x + y)$, because without such assumption his formula is incorrect. In any case, whatever the circumstances, equation (1) correctly gives the moment.

If, for instance, all the forces are equal to P_1 equation (1) gives at once $M_1 = P x - P a$, or the sum of the moments of two couples; the pin is curved in one direction only, not because I assume that it is, but because it has to be, and no amount of discussion can get out anything else for this case.

[If Mr. BUDDINGTON chooses to consider all the forces in one direction as "supports" of a continuous beam, and all the others as weights, there can be no objection. But even then we do not need the "Theorem of Three Moments," because this is only of use when the pressures on the supports are unknown. In the case of the pin, these are known, and equation (1) still applies. But what right has Mr. BUDDINGTON to assume his "supports" *on a level*? This seems just his trouble. Since it is evidently immaterial which forces we consider weights and which "supports," if he will conceive the *downward* forces in his diagram as "supports," he will have a beam with overhang at the ends, and will I think admit that the end acted upon by the force R_1 will be out of level as regards P_1. In any case equation (1) applies, and as shown by it, he should consistently write his result $+ M_1$ instead of $- M_1$. But whatever sign he prefers, it still remains true, that as long as $R_1 (x + y)$ is greater than $P_1 y$, the moment at P_3 will be greater not less than 103,044 and hence fibre stress greater not less than 68,000.]

Yours truly, A. J. DU BOIS.

Who Makes the Bi-lobe Meter?

OMAHA, Feb. 28 1888.

EDITOR ENGINEERING NEWS:

Will you kindly inform us who makes the "Shedd bi-lobe Meter?"

Yours truly,
THE AMERICAN WATER WORKS CO.
S. L. WILEY, Manager.

[We send the query afloat in the hope that parties interested may answer our correspondent's query, either directly or through these columns. ED. ENG. NEWS.]

Stresses in Pins.

PHOENIXVILLE, PA. March 6, 1888.

EDITOR ENGINEERING NEWS:

I notice in your issue of March 3, over the signature J. E. BUDDINGTON, a criticism of the method of pin designing used in ordinary engineering practice. Mr. BUDDINGTON states that the method prescribed in my "Stresses in Bridge and Roof Trusses," page 318, edition 1880 is erroneous. Will Mr. BUDDINGTON please state in just what respects my method is erroneous and also in just what particulars the method I give differs from that prescribed by Mr. COOPER in his specifications. If he (Mr. BUDDINGTON) will examine the second and third editions of my work, he will find a much more detailed treatment of the subject, although the principles are the same in all cases. Very truly yours,

WM. H. BURR.

The Design of the Quaker Bridge Dam.

PHILADELPHIA, March 3, 1888.

EDITOR ENGINEERING NEWS:

Will you please allow me a few words about the Quaker Bridge dam? I know that the discussions on the subject have already taken much space in your valuable paper; still I think it was not too much. This dam will surpass in magnitude any one ever constructed; it should be a model of engineering work. Instead of sending American engineers to Europe to study the construction of dams, we should see European engineers coming to this country to admire the great Quaker Bridge dam. America is at the head of all the nations in the construction of bridges, railroads, etc., why should it not be also at the head in the construction of dams? The good reputation of the Civil Engineers of this country should not be endangered by any mistake in the design of the Quaker Bridge dam.

It affords me great pleasure to see that your editorials on the subject lead to the same conclusion as my paper read before the Engineers' Club of Phila., Jan. 14, 1888, viz.: build the *gravity dam on a curve* and so introduce a *very much needed additional coefficient of safety.* (See ENGINEERING NEWS, Society Proceedings, Jan. 28, 1888).

I have proved that the increase of stability would be one hundred per cent.: that the excessive pressure

on the voussoir joints, as calculated by the designer, were a result of assumptions never realized in practice. The inertia of the mass of masonry was not taken into consideration.

I suppose your readers have heard of the "Great Bear Valley Dam" recently constructed in California. It is a curved dam, 60 ft. high, 20 ft. wide at the base, and 3 ft. wide at the top; the radius is 345 ft.

Calculating the maximum pressure on a voussoir joint by the formula used by the designer of the Quaker Bridge dam, we find that this pressure would be 29 tons per sq. ft. When the height will be increased by 20 ft., as contemplated, it would be 38 tons. Yet the engineer who designed the Great Bear Valley dam says that "the coefficient of safety is 25," and the State engineer of California has pronounced the work "not only efficient but a remarkable piece of engineering." Remember, that this dam could not stand even the static pressure of the water by gravity alone.

The objections raised against curved dams are nothing more than quotations from books written by scientific men, well posted on theory, but knowing little or nothing about practice. These objections are as follows:

1. If a dam is *strong enough* to resist by gravity, why should we build it on a curve? Ans: Can it be proved that the design of the Quaker Bridge dam considered as a gravity dam, is *strong enough*? The section is one of the weakest one ever constructed, or ever conceived. Simple good sense says: No danger, no precautions; more danger, more precautions. The design in effect says: "More danger less precautions. It is evident that the immense proportions of this dam would make its failure more disastrous than could be the case with any other dam in the world. Consequently this dam should have greater stability than other dams generally have, and the cheapest additional stability is certainly realized by the introduction of the curved plan.

2. A gravity dam will not act as an arch? Ans.: How do you know? If all the curved dams built in the world could tell you how many times they have been relieved by the reactions of the abutments, when some undue strains were oppressing their stability, then you would apologize.

3. The curved dam costs much more. Ans.: The number of cubic yards will be increased by 3 per cent. if a radius of 900 ft. is adopted. The rubble masonry generally used in straight dams is unfit to sustain lateral strains. Some extra care is required in building a curved dam, for which I add 10 per cent., making a total of 13 per cent.

Is 100 per cent. increase of stability not worth 13 per cent. extra cost?

Your remarks concerning the appearance of the constructions, as well in plans as in elevation, are entirely in accordance with my views on the subject. On May 21, 1887, I presented to the Engineers' Club of Philadelphia a diagram giving the profile of dams for any height of water. On Oct. 15, I showed to the club a sketch comparing the profile of the proposed Quaker Bridge dam with the one taken from the above referred diagrams. The stability was increased in appearance and in reality; it was a *curved* profile giving satisfaction to the engineer and to the architect.

Yours respectfully,
A. MARICHAL, C. E., Phila. Water Dept.

[We have not had the pleasure of reading Mr. MARICHAL'S paper, but we are at a loss to understand how it can be "demonstrated" that a curved dam will be 100 per cent. or any other specific per cent. stronger than a straight. The advantage comes in, first, in a much more than 100 per cent. increase in case of an emergency like an earthquake, and secondly, in a certain structural advantage tending to the consolidation of the mass and the prevention of cracks which is essentially indeterminate and incomputable.—ED. ENG. NEWS.]

Switch-backs: their Use and Construction.

Union Pacific Ry.; Construction Department.
DILLON, Colo., Feb. 25, 1888.

EDITOR ENGINEERING NEWS:

While reading that portion of Mr. WELLINGTON'S valuable work on the "Economic Theory of the Location of Railways" pertaining to the use of switchbacks for overcoming high summits, I was struck with the theoretical adjustment of grade there outlined (p. 947, cut reproduced herewith) and even now do not see how it could work under all the varying conditions to which it might be subject. For instance, the loading; the condition of the rail; the steam pressure, and many other causes might often conspire to make the actual speed of an ascending train vary widely from the theoretical speed necessary to work in harmony with the grade adjustment of the tail as the train passes the head block. Or, to be more explicit, suppose the case (a frequent one in practice) of a heavy train laboring up hill at a speed of 6 or 8 miles per hour as the best it can do, and a grade adjustment on the approaching tail adapted for a 15 mile per hour speed, then how can that train ever enter the tail far enough to clear the switch—for it seems to me the increased grade of tail necessary to check a 15 mile speed, say 100 ft. beyond the switch—would, without doubt stall the train at 6 mile speed before the whole train could clear.

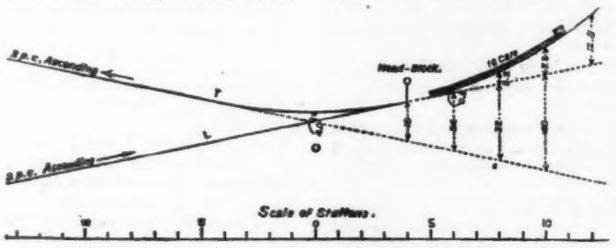
Therefore, to make any given adjustment of tail grades work successfully, it is absolutely essential that the speed upon entering it should always be approximately that for which the grade adjustment was made, a condition which it seems to me is not always obtainable, and when not, must result in considerable inconvenience and delay.

Neither do I see how a lengthening of the tail and the carrying of the main grade a corresponding distance up beyond the switch would improve things, for, even though that would let a low speed train in and out again, (not however in strict accordance with the principle) yet for trains of ordinary speed, and for which the grade on tail was designed, it would allow too great a drop on the return for safe speed, for where switch-backs are resorted to it will very often be found that they are on very rough ground, rendering a straight away location impossible except at much greater cost, and necessitating very sharp curvature in connection with the frog and switch points, as in the case of the recently built Stampede switch-back over the Cascade range on the Northern Pacific Railroad in Washington Territory.

I do not write the above in a criticizing spirit, but rather as a statement of the case as it appears to me.

Yours truly,
J. A. BARLOW,
Div. Eng. U. P. Ry.

[We have commented on this letter on the Editorial page.—ED. ENG. NEWS.]



Grades on Switchbacks.

Pin Details.

Department of Engineering,
UNIVERSITY OF VIRGINIA, VA., Feb. 25, 1888.

EDITOR ENGINEERING NEWS:

In looking over the discussion in your columns of the best ways of assembling truss members on the pins, I have been struck with the very clear manner in which the case reported by Mr. OSBORN, (page 122), illustrates the difficulty of laying down any fixed rules of arrangement. As will plainly appear from the calculations which accompany this note, the arrangement reprehended by Prof. JOHNSON, (page 65,) and justly for the case considered by him, is in this case the best. The truth is, that in such matters it is not safe to lay down anything absolutely except *the general principle*. In pin proportioning this is to keep the *shears* as *small* as possible and of *alternating signs*, nothing more than this can be stated generally. The details which produce the result must be left to the designer.

Details of pin joints, modified from ENGINEERING NEWS, February, 1888, page 122, would read as follows:—Loads in tons, lever arms in inches. Round numbers are used.

First joint.

(1.) *Actual Arrangement.*

Loads.	Bearing Lengths.	Shears.	Lever Arms.	Moments.
+23	1⅛	+23	1	+23
−15	¾	+ 8	1	+ 8
+23	1⅛	+31	1	+31
−15	¾	+16	1⅜	+22
−16	1⅞	0		
				84

Stress due to bending, 55 tons per sq. in.

(2.) *Prof. Johnson's Arrangement.*

Loads.	Bearing Lengths	Shears.	Lever Arms.	Moments.
+23	1⅛	+23	1	+23
−15	¾	+ 8	1⅜	+6.5
−15	¾	− 7	1	− 7
+23	1⅛	+16	1⅝	25
−16	1⅞			
				47.5

Stress due to bending, 31 tons per sq. in.

(3.) *Better Arrangement.*

Loads.	Bearing Lengths.	Shears.	Lever Arms.	Moments.
−15	¾	−15	1	−15
+23	1⅛	+ 8	1	+ 8
−15	¾	− 7	1	− 7
+23	1⅛	+16	1⅝	+25
−16	1⅞			
				11

Stress due to bending 7.2 tons per sq. in.

In the other case the stresses are 51, 35½, 25 tons per square inch corresponding to moments of 78, 54½, 38 inch tons. The pin in both cases is obviously too small.

Very respectfully,
WM. M. THORNTON,

Not the City Engineer.

NEW BRUNSWICK, N. J., March, 6th, 1888.

EDITOR ENGINEERING NEWS:

In your note concerning the New Brunswick Dam in issue of March 3, you imply that I am *the* City Surveyor of New Brunswick. You do me too much honor (?) I am simply *a* City Surveyor of New Brunswick without any desire to change the indefinite for the definite article.

GEO. HILL.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—The regular meeting of the Society was held March 7, MENDES COHEN in the chair and a number of members and visitors present. Just after the ballots had been closed Mr. COHEN read a letter from a member asking that his vote for a certain candidate be changed to "Nay". As this was without precedent, Mr. COHEN put the matter before the meeting, and the vote resulted in 17 in favor of making the change and 4 in opposition. The paper of the evening, "Test of an Incandescent Electric Lighting Plant," by JOHN W. HILL, M. Am. Soc. C. E., was read by the secretary. The test was of the plant at the Cincinnati union depot, where the electric light company furnishes the engines, plant and lamps, and the depot company furnishes the boilers and supplys steam. The contract provided that the depot must be lighted for one week in the year with gas and that if the cost for this week is less than the cost of the electric light, the cost of the latter must be reduced. The paper was discussed by some of the visitors, and it was stated by Mr. HOWELL, who went to look after the interests of the electric light company, that the tests was made by the gas company and that he was not allowed to have any voice in the matter. The result was, however, that the cost of electric lighting was less than gas lighting.

It was announced that the Norman Medal has been awarded to Mr. DESMOND FITZGERALD for his paper on "Evaporation," and the Rowland Prize to Mr. METCALF for his paper on "Steel."

The result of the ballot on amendments to the constitution is given on our Engineering News page. The following candidates were elected:

Members.—FRED. JAMES AMWEG, in charge of Market St. bridge, Philadelphia, Pa.

OBERLIN MATTHIES CARTER, river and harbor improvements, Savannah, Ga.

CHARLES SEWALL GOWEN, Division Engineer, New Croton Aqueduct, Sing Sing, N. Y.

CHARLES DAVIS JAMESON, Consulting Engineer, New York City.

EDWARD JOHN LANDOR, Chief Engineer, Wrought Iron Bridge Co., Canton, O.

HUNTER MCDONALD, Assistant Engineer, Nashville, Chattanooga & St. Louis Ry., New Market, Ala.

GEORGE ROMAINE OLNEY, Assistant Engineer, New Croton Aqueduct, Morris Dock, N. Y.

FRANCIS ENSOR PRENDERGAST, Assistant Engineer, New York & New England R. R., Newton Highlands, Mass.

GEORGE HENRY ROBINSON, Engineer and Assistant General Manager, The Montana Co., Marysville, Mont.

EDWARD WEGMANN, Jr., Division Engineer, New Croton Aqueduct, Englewood, N. J.

ARTHUR OWEN WILSON, Birmingham, Ala.

JOHN YOUNG, Engineer, Geneseo Water Works, Geneseo, N. Y.

Associate.—JOHN HAINES WARDER, Edge Moor Iron Works, Wilmington, Del.

Juniors.—DAVID SYLVANUS CARLL, Assistant Engineer, Grand Ave., Cable Co., Kansas City, Mo.

CHARLES ALFRED HASBROUCK, Assistant Engineer, Detroit Bridge and Iron Works, Detroit, Mich.

The New Engineers' Club.—In answer to numerous inquiries as to what progress is being made in the formation of an Engineers' Club in New York City, the following brief statement has been prepared:

A meeting, composed of leading Engineers of the various Engineering Societies residing in New York and vicinity, was held in the rooms of the American Society of Civil Engineers, 127 East 23d Street, on the evening of Feb. 3, 1888, Dr. THOS. EGLESTON presiding.

Upon the unanimous vote of those present, as well as in accordance with the views of many who could not be present but who sent letters expressive of the same desire, it was decided to organize a Social Club, with headquarters in New York, for the accommodation of resident and non-resident engineers in the several fields of professional work.

As the first step toward carrying out this decision, the following gentlemen were elected officers to organize the club and hold office until the first annual meeting:

President, JAS. A. BURDEN; *First Vice-President*, H. R. TOWNE: *Second Vice-President*, J. C. BAYLES; *Secretary*, DAVID WILLIAMS.

Board of Managers: B. S. CHURCH, W. A. PERRY, EDWARD COOPER, J. C. PLATT, THOS. EGLESTON, A. C. RAND, W. G. HAMILTON, R. W. RAYMOND, J. F. HOLLOWAY, F. S. WITHERBEE.

Mr. TOWNE, Vice-President, thereupon took the chair, and after full discussion in regard to the details of organization, the following recommendations were made to these officers as expressing the sense of the meeting:

That the name be The Engineers' Club.

That persons residing in New York City, or within a radius of 150 miles, be received only as resident members.

That persons residing at any distance beyond the above-named limit may be received as non-resident members.

That the initiation fee for the first 250 members, whether resident or non-resident, be $50 and the annual dues for resident members be $35; for non-resident, $20; the year of the Club to begin on the 1st of January and the annual dues to be payable on the 1st of Jan. and the 1st of July.

That the clauses defining eligibility to membership in the Mining, Civil and Mechanical Engineers' Societies be accepted by the Membership Committee as defining the qualifications for club membership.

The following Committies were appointed: on Membership, By-Laws, Incorporation, Library, Location.

As soon as the several committees have completed their work and are ready to report, a general meeting of all whose applications for admission have been favorably acted upon will be called, of which due notice will be given.

From present indications it is deemed probable that the club will start with a membership of at least 300, and that its numbers will steadily increase in the future.

DAVID WILLIAMS, *Secretary*.

66 and 68 Duane Street, New York.

American Institute of Mining Engineers.

(*Concluded from page 167.*)

At the afternoon session, Feb. 22, a paper was read on the "Application of Electricity to Mining" by GEO. W. MANSFIELD, of the Thomson-Houston Electric Co., Boston. He set out to prove three points: 1, that the electric system and motor is the simplest mechanism for transforming power into mechanical work; 2, that the system is still in its infancy, and 3, that the electric dynamo and motor is the best method of transmitting power through small and great distances. He described the construction of the dynamo, and said that, simply a drum having coils of wire wound upon it, so as to form an electro-magnet, between the poles of which a core wound with wire, or an armature supported upon two bearings, is rotated, in which the electric current is generated, and is taken off by a collector. The power for producing the electric current is chiefly derived from water or steam. In Boston, 2,500 H. P. running 3,000 lights are used every night. It has been transmitted through all distances up to 50 miles. It is perfectly practicable to transmit the 5,000,000 H. P. from Niagara Falls. There are now 250,000 H. P. used for lighting in this country every night. An arc light requires .8 H. P. of electric energy.

Electric H P. at generating station.	Commercial H.P. at receiving station.	Miles distant.	Diam. of wire inches.	Cost of wire.	Cost of erecting line.	Cost of dynamo.	Cost of motors.	Total electric cost.	Total steam and electric cost.	Total turbine and electric cost.
30	25	50	.50	$79,500	$15,000	$2,000	$1,500	$98,050	$101,550	$98,550
67	55	10	.34	8,362	2,000	3,500	3 000	16,862	21,862	17,662
730	600	10	1.13	81,100	5.000	37,500	30,000	153 600	197,400	158,600

If power for lighting has been thus transmitted, it is equally practicable to furnish power for motors situated at any of these scattered points where lights are used. After stating that the efficiency of dynamos and motors are now from 90 to 96 per cent., he considered the applications to mining under the following heads: 1, drilling and excavating; 2, hoisting; 3, hauling; 4, transporting; 5, pumping; 6, ventilating and 7, in replacing other machinery, such as stamps, etc.

The best known application to mines is that at the Zankerode mines, near Dresden. The cost of installation was $4,000, and there are 800 cars in use transporting the material at a cost of 1½ cents per ton mile. Under the head of transporting, the Ayston and Perry tugshorage system was briefly described, and the Chandler wire transportation system which has the lightest weight of any machine for a given power. For pumping, the use of electricty is superior to the use of compressed air. All machinery except the motor is on the surface with only two wires running down the shaft, offering no obstruction, and the motor is especially adapted for running centrifugal pumps.

In regard to mine ventilating he thought a number of small motors, driving fans, and located at points where air was specially needed, was better than a single large 30-ft. fan, for instance, at the mouth of shaft. He favored the establishment of a company to supply electric power, with a station at the foot of the mountain, in a mining district, from which wires could be run up the mountain to the various mine shafts, and gave the following figures as to costs, in three cases:

In answer to question of W. F. DURFEE, he thought safety from fire made the electric the best system. Wires would be more heavily insulated and perfectly put up, there would be no danger. The lamps would be enclosed in wire gauge. If a wire was broken by a roof fall a spark of extremely short duration only, would result, and wires need not be laid in fiery mines.

E. B. COXE thought power would not be required at dangerous points, ordinarily. The introduction of electricity for underground transportation was an assured success. In the Pennsylvania R. R. mines the current is carried through the rails for about 6,000 ft.

C. E. EMERY said electric motros in buildings must have a high efficiency in order not to heat and cause danger. He had recently investigated this subject but in a certain case found the cost of turbines, dynamos, motors and compressors too great and adopted compressed air in thin pipes, which he carried 14 miles. He was, however, favorable to electricity and had the greatest faith in it at a growing business.

The first paper proper of the session, which was devoted to metallurgy, was on "Some Modern Improvements in Open Hearth Steel Practice," by A. E. HUNT of the Pittsburg Testing Laboratory, in which a new method developed by the Carbon Iron Co., of Pittsburg, was described as employed, using a peculiar graphite as reducing agent. An abstract of this paper will be given later.

H. M. HOWE said the process had nothing to recommend it, apparently, and yet has become a success. Mr. HUNT originally thought the process was, must and ought to be a failure but after weeks of actual weighing he had to admit he was wrong. W. F. DURFEE said iron could be manufactured in Rhode Island, with a proper mixture of foreign ore, as cheaply as in Pennsylvania. F. RAYMOND refferred to A. L. HOLLEY's speech on the resources of Penn. and New England.

The next paper was on "The Husgarfel Furnace for Making Malleable Iron," by F. L. GARRISON, of Philadelphia. The process is not new but an improvement on the old bloomery furnace.

The last paper of the session was on "The Bofors Steel Gun," by Capt. O. E. MICAELIS, of the Kennebec Arsenal, Augusta, Me., in which data were given from Swedish practice, the guns being made of unforged open hearth steel. The Swedish Government made extensive tests of these guns. Among them, guns carrying 32 to 73 lbs. weight of projectiles with 7½ to 9 lbs. of powder stood 1,041 rounds, some enlarging enormously without bursting. He preferred cast to forged steel, and said he knew no reason why the hammer and hydraulic press should not be done away with.

A. E. HUNT said that the Pittsburg Steel Casting Co., think they have solved the problem there with similar results, and thought cast steel would be used in the future instead of making built up guns, the same opinion being also expressed by President EGLESTON. The evening was given to a subscription dinner at the Hotel Brunswick.

Thursday, Feb. 23, was given up to an excursion by special train on the Fitchburg railroad, to Fitchburg, Mass., the party numbering about 150. The works of the Simonds Steel & Iron Forging Co., were visited where the very interesting plant, consisting of some 14 machines of all sizes, was in operation rolling finished steel pieces from the heated bars. The rolling machines, the invention of Mr. GEO F. SIMONDS the well known manufacturer of saws, in Fitchburg, has been developed since 1884 and appears to be the germ of a revolution in the present methods of working iron and steel. The results are certainly wonderful.

The developing company was organized in Boston, in Nov. 1886, with $400,000 capital. An English company has also been formed, having among its directors Lord THURLOW, director of the Sir William Armstrong Works; Admiral Sir COOPER KEY, G. C. B., Chairman of the Nordenfelt Gun and Ammunition Co.; Lord SUDELEY, Chairman of the Chatworth Gunpowder Co.; R. C. CHRISTIE, Chairman of the Sir Joseph Whitworth Co.; C. H. FIRTH, Chairman of Thomas Firth & Sons, of Sheffield and other gentlemen of similar standing. Steel Nordenfelt conical shot to the number of 500,000 have already been manufactured by this company for the English Government. It is said the foreign patents alone have been sold for $500,000.

The American Company are filling orders for and manufacturing the following articles: wagon axles, steel spindles, wrist pins, monkey wrench, monkey wrench screws, screw taps, 2 in. balls, perfectly spherical, chair screws, taper pins, lumbermen boot calks, horse shoe calks, cap screws, harness staples, ball bearings, for bicycles, tricycles, etc., 40 calibre projectiles and small balls, of all sizes, and all these products being rolled into shape by a single motion of the machine from the bar of iron or steel. The bars are heated to red heat in small furnaces near the machines, and then fed between die plates of the required shapes which have a vertical or horizontal motion, and roll over the bar, giving the required shape by compression of the material. The production of mill spindles by the hammer did not formerly exceed 400 per day, while one Simonds machine will produce 2,000 per day, uniformly rolled. Of boot calks, where 2,000 per day has been an average, one of these machines makes 18,000. Screws are perfectly formed, requiring no finishing and retaining the entire strength of the bar from which they are made, since the threads are upset and compressed by the machine with no loss of material. A conical rifle shot was shown which had penetrated a steel bar 1-in. thick with no injury to the shot. Railroad track fish plate bolts, of which 60,000,000 are used in this country in a year, are also being made.

After a lunch and brief visit to the Simond's Saw Works, where circular saws up to 74 in. diameter were in process of manufacture, the Putman Machine Co. and Fitchburg Steam Engine Co., the afternoon was spent at the Waltham Watch Co.'s extensive factories, and in inspecting the Government Testing Machine at the Watertown Arsenal. The watch factori s employ 2,500 operatives, many being women, there being 3,700 operations in making the watches, an ordinary watch comprising about 160 pieces.

At the fourth session, Thursday evening, Feb. 23, an account of the Boston Heating Company's plant was given by A. V. Abbott, the Engineer in Charge of Construction. Further details of this novel and interesting plant, beyond those already described in previous issues will be given at another time. The next paper was on "The Phosphates of the Ottawa Valley," by ROBERT BELL, of Ottawa, Canada. Phosphates occur in

most rocks, and they occur in veins, not in bedded rock Joints have been filled with them by slow degrees. The total quantity produced in Canada is about 25,000 tons per year, practically all being exported to England and thence to Germany and other points on the Continent Veins are from 6 ins. or 1 ft. in width to 10 ft.; 80 to 85 per cent. are pure crystals. The next two papers, 'On the Ore t reasing Works of St. Joseph," and "The Theory of Jigging," were by Prof. H. S. MUNROE, of N. Y. Major HOTCHKISS, of Staunton, Va., began an account of "A New Gas Coal of Western Virginia," which was finished at the Friday evening session.

The last day, Friday, Feb. 24, of the meeting, was devoted to minor excursions in small parties, with guides to the following places: Clapp-Griffith's Steel, Works, Wareham; Lawrence Cotton Mills; Tyler's Tube Mills; Merrill Air Engine, Donner Kerosene Oil Works; Chestnut Hill Reservoir Pumping Station; Boston Society of Civil Engineers, Boston Art and St Botolph Clubs; Blake Pump Works; Golden Gate Concentrator; Boston Heating Co's Station; Sturtevant Mill; Harvard University; Meigs Elevated Railway Works; Mitis Wrought Iron Casting Co.; Neponset Boston Sewage Pumping Station; Norway Iron Works; South Boston Iron Works; Ames Shovel Works, North Easton; Laboratories of the Institute of Technology; Art Museum and Natural History Society, and the Thomson-Houston Electric Light Machinery Works, at Lynn. At the last named place, besides a view of their extensive plant and operations the new industry of electric welding was observed with great interest. Here, without furnaces, hammers or fire, bars of different materials and of all sizes, were instantly united by the passage t hrough them of the electric current.

At the closing session, Friday evening, at the Institute of Technology, 103 new members from all parts of the country were voted for, 4 Honorary Members being admitted, and the Report of the Council was read. Receipts from all sources for the year ending Jan. 31, 1888, including the balance at beginning of year, were $23,282 and expenses, $18,667, including amount expended in the purchase of U. S. bonds; surplus, $4,615. Actual receipts of year were $2,829 greater than expenses. During the year 200 Members and 29 Associates have been elected; 11 Members and 1 Associate have died. The total present membership, including those elected at the meeting is 1,817.

The following officers elected: President (term 1 year) Prof. W. B. POTTER, Washington University, St. Louis, Mo.; Vice-Presidents (term 2 years, 3 elected every year), J. C. BAYLES, Editor of *Iron Age* and President Board of Health, New York City; ALFRED E. HUNT, chemist and metallurgist, Pittsburg, Pa.; Prof. T. STERRY HUNT, geologist, Montreal, Canada; managers (term 3 years, 3 elected every year), ROBERT FORSYTH, Supt. Union Steel Works, Chicago; KENNETH ROBERTSON, manager Floss Iron Co., Birmingham, Ala.; CHARLES M. ROLKER, mining engineer, New York City; treasurer, THEODORE D. BAND, Philadelphia; Secretary, R. W. RAYMOND, New York City.

Other papers, read by title, were "The La Plata del Libano Mines, Colombia," by W. I. PIERCE, New York City; "Western Kentucky Coals and Cokes," by J. H. ALLEN, Mannington, Ky.; "Bedded Ore Deposit of Red Mountain, Col.," by G. E. KEDZIE, Ouray, Col.; "Steel Rails," by F. A. DELANO, Chicago; "The Thermal Properties of Slags," by H. M. HOWE, Boston; "Through-Lixiviation," by OTTOKAR HOFMANN, Alameda, Cal.; "Notes on a New Device for Operating Blast-Furnace Charging Bells," by F. C. ROBERTS, Philadelphia; "The Determination of Silica in Cinder," by R. H. LEE, Lewistown, Pa; "A Method for the Estimation of Manganese in Steel," by FRANK JULIAN, Chicago; "A Glossary of Furnace Terms, in English, French and German," by THOMAS EGLESTON, New York City; "Prominent Sources of Iron Ore Supply," by JOHN BIRKINBINE, Philadelphia, and "Note on an Asphaltic Mineral from Utah," by T. M. DROWN, Boston.

Major HOTCHKISS in continuing an address on what will be comprised in three papers in the Transactions, spoke of the Nomenclature of the Coal Basin of the Appalachian Water Shed, which he showed should be called that of the Ohio river. The size of this basin is 800 miles long by about 200 wide, situated on the western slope of the Atlantic Highlands. The coking coal beds here are very valuable. The gas coals of the region beyond contain 38½ per cent. of volatile matter, with but 3 per cent. of ash and 1¾ per cent. of water, the remainder of fixed carbon. These coals were compared with those of the Pennsylvania region and their superiority for making a better grade of iron shown.

After the customary votes of thanks the meeting was adjourned.

CONSTRUCTION NEWS.

Proposals Open.

Gas Wells.—Three or more wells. R. H. BOUSLOG, Secretary, Citizens' Gas & Pipe Line Co., Peru, Ind.

Sewers.—Plans and specifications on file. GEO. E. POND, Assistant Quartermaster, U. S. A., Fort Riley, Kan. March 13.

Street Sweeping Machine.—F. E. KUHN, Secretary, Board of Public Works & Affairs, Nashville, Tenn. March 13.

Iron Bridge.—Length 85 ft., width 14 ft.; capacity 90 lbs. per sq. ft. JOSEPH TRUDEAU, City Clerk, Montreal, Canada. March 13.

Pipe, Hydrants, Etc.—Pipes, valves and hydrants, including laying; pipes to be of wood. Plans and specifications at the office of the Hammond Milling Co H. HALL, Clerk, Water Trustees, Hammond, Ind. March 13.

Reservoir Work.—East Park reservoir; concrete and brick lining of northeast section; coping stones for gate houses; horses, carts, and drivers; horses and drivers for rollers; watering carts, horse and driver; clay for lining. LOUIS WAGNER, Director of Department of Public Works, Philadelphia, Pa. March 13.

Sea Wall.—Rebuilding sea-wall on Roxbury canal. Plans and specifications at the office of the City Engineer, H. T. ROCKWELL, Chairman, Water Board, Boston, Mass. March 14.

Brick and Cement.—Best gray brick, 100,000; 250 barrels cement. J. S. VERNER, Secretary, State House Commission, Columbia, S. C. March 15.

Pier and Bulkhead.—At foot of E. 46th St. THE DOCK COMMISSIONERS, Pier A, North river, New York City. March 16.

Pipe and Pipe Laying.—Furnishing 5,230 of 3, 4, 4½, 6 and 8-in. wrought-iron pipe and cast-iron fittings. Also laying 1,083 lengths of 3, 4, 6, 8 and 10-in. cast-iron pipe, with hydrant branches and valves. JOHN A. GITHENS, Water Commissioner, Asbury Park, N. J. March 17.

City Building.—Cost not to exceed $35,000. JOHN D. KIEFER, Chairman of Committee, Urbana, O. March 17.

Electric Lighting.—Furnishing and maintaining 15 to 40 street arc lights and 100 incandescent lights, and operating same for 1 to 5 years. OBED STORR, City Clerk, Urbana, O. March 17.

Sewers.—Storm sewers for Sewer District No. 1. O. N. GARDNER, City Engineer. AUSTIN HUMPHREY, Chairman, Board of Public Works, Lincoln, Neb. March 17.

Fencing.—Fence 6 ft. 6 ins. high; 4 in. chestnut posts, 2×4-in. chestnut rails, 10×1½-in. spruce or pine base boards, 9×1-in. spruce upright boards, 12 and 30 d nails Price per lin. ft. THOS. J. LANAHAN, Clerk, Board of Contract, Albany, N. Y. March 19.

Removing Street Dirt, Etc.—THOS. J. LANAHAN, (*as above*), Albany, N. Y. March 19.

Street Work.—Dimension granite blocks, curbing, cross-walks, etc. THOS. J. LANAHAN, (*as above*), Albany, N. Y. March 19.

Court House.—Brick building or stone building. E. T. HEINER, Houston, Tex., architect. Hon. J. M. SMITHER County Judge, Huntsville, Tex. March 21.

Sewerage System.—Complete system for U. S. barracks. Col. GUNTHER, U. S. A., Little Rock, Ark. March 21.

Court House.—Plans and specifications on file. W. H. GARDNER, Chairman, Building Committee, Union City, Tenn. March 24.

Boilers.—Five Babcock & Wilcox boilers, including setting; aggregate 1,040 H. P.; arranged in 3 batteries. JAMES FULTON, Paymaster General, U. S. N., Navy Department, Washington, D. C. March 27.

Street Work.—Brick and freestone sidewalks; grading, curbing, culvert, drains, etc. F. H. STANLEY, City Engineer, Cincinnati, O. March 27.

Court House and Jail.—Bids for buildings, separate bids for iron and steel work of jail. E. T. HEINER, architect, Houston, Tex. Hon. W. J. CROOM, County Judge, Wharton, Tex. March 27.

Dimension Stone.—For walls of cellar of Congressional Library Building. EDWARD CLARK, Architect of the Capitol, 145 E. Capitol St., Washington, D. C., March 31.

Railroad.—Track-laying and ballasting, buildings, etc., for the Guelph Junction Ry., 15½ miles. Plans and specifications at the Engineer's office, Guelph, Ont. JOHN M. BOND, Secretary and Treasurer, Guelph Junction Ry., Guelph, Ont., Canada, April 2.

Jail and Jailers' Residence.—Stone building, iron doors, guards, beams and ceilings; heating apparatus, sewerage, etc. DODSON & DUDLEY, architects, Waco, Tex. THE COUNTY COMMISSIONERS, Georgetown, Tex. April 16.

Contracting.

Artesian Wells for China.—It is reported that the Chinese authorities contemplate having a number of artesian wells bored.

Federal Building.—The contract for the basement of the Federal Building at Brooklyn, N. Y., has been awarded to Cox & Co., in which firm Michael J. Dady is interested, for $38,477. The next bid was $43,000.

Boilers.—The Laidlaw & Dunn Co., of Cincinnati, O., has been awarded the contract to supply two 7 ft. x 28 ft. Galloway boilers, 300 H. P. each, and the pumps to supply same, for the Electric Lighting Department in Washington Park at the coming Cincinnati Centennial Exposition.

The National Street Sweeping Machine Co. has been incorporated at Chicago by CHAS. A. RADDIN, W. W. WATSON and L. A. GILBERT. Capital stock, $250,000.

Water-Works.—The Henrietta Improvement Co., Henrietta, Tex., will let contracts for water-works by the end of this month. The supply will be drawn from artesian wells and pumped to a reservoir, tank or stand-pipe. Population 2,500 to 3,000. J. B. HOPKINS is President of the Company.

New Croton Aqueduct.—The only bids for work on Sections No. 1 and No. 3, received by the Aqueduct Commissioners, were from W. E. Dean and O'Brien & Clark.

Dam.—The Flynt Building & Construction Co., of Palmer, Mass., has the contract for a granite dam at Chicopee, Mass., to cost $40,000, for the Dwight Co., to replace the one recently washed away.

The Western Engineering Co. has been incorporated at Lincoln, Neb., by J. G. WHITE, W. F. WHITE and D. C. JACKSON, to contract for electric apparatus.

Rolling Stock.—The Pennsylvania R. R. Co. will expend $2,000,000 on new rolling stock. The company has 3,000 gondola cars and 2,000 box cars under contract, and will add 25 locomotives to its equipment.—The Lafayette Car Works, Lafayette, Ind., have contracts for 3,000 freight cars.

Pumping Station.—The contract for the pumping station of the water-works at Jeffersonville, Ind., has been awarded to Capt. J. E. Thickstun.

Dummy Engines.—The Nashville & West Nashville Ry. Co., of Nashville, Tenn., will purchase dummy engines.

City Hall.—The following proposals for the construction of a city hall at Garrettsville, O., have been received by E. S. DAVIS, Village Clerk: M. Kenny & S. Crittenden, Burton, O., $16,950; Gloin & Moffett, Chardon, O., $17,599; Thomas Thomas, Paris, O., $18,700; J. F. Oviatt, Cleveland, O., $19,720; C. Jockel, Cleveland, O., $20,340; John Olive, Cleveland, O., $20,370.

Street Work.—*Brooklyn, N. Y.*—The following proposals for flagging sidewalks have been received by the Commissioner of City Works: C. S. Lynan, 19 cts. per sq. ft.; Thos. R. McCann, 22 cts.; J. McGrath, 22 cts.

Baltimore, Md.—The following proposals have been received by A. E. SMYTH, City Commissioner: flagstones and Belgian blocks, John Curley, 25 cts. per sq. ft., $1.25 per sq. yd.; J. H. Atkinson, 18 cts., $1; John Harris, 25 cts., $1.25. Gutter plates; J. J. Lacy & Co., 1¾ cts. per lb.; J. V. Campbell, 1¾ cts.; J. Walz & Co., 1¾ cts. Sand: J. A Lloyd & Sons, 60 and 75 cts. per cu. yd.; J. P. McGovern, 70 cts.; P. Kellty, 70 cts.; W. E. Anderson, 79 cts.; Patrick Reddington, 80 cts.; Morgan & Brennan, 90 cts.; John Devin, 90 cts. Cobblestone, John Harris, $1.35 per perch; J. G. Schwind, $1.42½; D. Leonard, $1.45; J. H. Atkinson, $1.75; J. Curley, $1.90.

Albany, N. Y.—All the bids for repaving Clinton avenue with granite blocks were rejected as too high.

St. Louis, Mo.—Contracts for granite paving have been awarded by HENRY FLAD, President, Board of Public Improvements, as follows: Stifel & Ruckert, $19,949.70, $19,136.30; Julius A. Schneider, $13,499.20, $17,011.50, $7,878.20; Allen & Vieths, $9,707, $11,097.60, $10,591.25; $20,099.04; $25,062.44; J. B. O'Meara, $26,026.25; Fred Skrainka, $14,066.18.

Sewers.—*St. Louis, Mo.*—The following contracts for pipe sewers have been awarded by HENRY FLAD, President Board of Public Improvements: Robert Sheehan, 745 ft. of 15-in. and 190 ft. of 12-in., $1,259; 340 ft. of 15-in. and 30 ft. of 12 in., $500.04; 200 ft. of 15-in. and 350 ft. of 12-in., $788.31; Lewis Grund, 20 ft. of 15-in. and 290 ft. of 12-in., $400.74; John Casey, 660 ft. of 12-in. $712.76; R. Wycoff and B. Crean, 140 ft. of 18 in., 1,730 ft. of 15-in. and 240 ft. of 12-in., $2,597.75; 415 ft. of 15-in. and 180 ft. of 12-in., $699.96.

Kansas City, Mo.—Contracts have been awarded as follows: in District 84; C. W. Cadagan, 36, 30, 26 and 24-in. brick, $3.50, $2.80, $2.75 and $2.69; 18, 15 and 12-in. pipe, $1.52, $1.20 and $1; manholes, $40; catch basins, $60 and $90; rubble masonry, $3.50; rock excavation, $3.75; riprap, $1; total, $29,864.66. The other bidders were, Oscar Downing, $30 609.50; A. Duer, $30,539 50; J. A. Tiernan, $31 401.84; J. J. Armstrong, $31,541.99; Howard A. Williams, $33 716.50; F. T. Mulholland, $34,786.36; T. C. Lidwell, $35.665.35; E. C. Cooledge, $43,017.16.—In District 118; Oscar Downing, $18,724.35; A. Duer, $18.818.27; H. A. Williams, $19,812.35; J. J. Armstrong, $20,623.80; Geo. J. Baer, $20,714.15; T. C. Lidwell, $21,651.50; Wm. Shaw, $22,034.50; E. C. Cooledge, $28,340.38. Contract awarded to O. Downing.

The Kansas Improvement Co. has been incorporated at Topeka, Kan., to build railroads, etc. Capital stock, $500,000.

Retaining Wall.—The following proposals for the construction of a retaining wall at Syracuse, N. Y., have been received by JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y.: Lane & Brummelkamp, Syracuse, $3,274; Wm. Patrick, Phoenix, N. Y., $3,460; John Brown, Mohawk, N. Y., $4,490.50; Hughes Bros., Syracuse, $4,745. The contract was awarded to Lane & Brummelkamp.

Supplies.—The following contracts have been awarded by JAMES FULTON, Paymaster General, U. S. N., Navy Department, Washington, D. C.: copper tubing, American Tube Works, Boston; wire rope, Robt. Boyd, Washington; sperm oil, hexagon nuts, iron washers and white chalk, J. E. Bates, Washington; charcoal, screw wrenches and gum packing, J. B. Kendall, Washington; oil stone, R. W. Creed, New York; neatsfoot oil, Manhattan Oil Co., New York; stencil paper and gum camphor, J. R. Michael, New York.

Sewers.—The following proposals have been received by ALBERT B. HILL, City Engineer, New Haven, Conn.:

Sewer in Davenport Avenue.

Bidders.	Brick. 64-in.	48-in.	42-in.	36-in.	30-in.	24-in.	Pipe. 18-in.	15-in.	12 in. culvert.	Catch basins.	Manholes.	3d class masonry.	Pile foundation.	Total.
Anthony Carroll, New Haven.	$8.75	$8.00	$7.60	$7.50	$5.25	$3.90	$2.15	$1.90	$1.25	$105.00	$55.00	$8.00	$3.00	$29,369.50
Patrick Maher, New Haven.	8.70	8.00	7.55	7.55	5.20	3.85	3.00	1.85	1.25	105.00	55.00	7.87	6.25	29,311.00
C. W. Blakeslee & Sons, New Haven.	9.40	7.80	6.75	6.60	5.05	4.40	2.60	2.15	1.20	100.00	50.00	9.85	5.10	26,769.00
Matthew Kelly, New Haven.	8.50	7.50	7.00	6.20	4.50	4.00	2.40	2.00	1.50	105.00	55.00	10.00	5.50	26,000.00
Laurence O'Brien New Haven.	8.00	7.00	7.00	6.00	4.50	3.50	2.80	2.00	1.50	110.00	60.00	9.00	6.00	26,392.00
Harris & Maguire, Brooklyn, N. Y.	9.43	8.33	7.16	5.80	5.28	4.72	2.09	1.76	1.10	77.00	44.00	7.60	5.00	24,763.20
A. Brazos & Sons, Middlefield, Conn.	9.35	7.50	6.24	5.83	4.38	3.60	2.30	2.08	1.25	100.00	50.00	10.00	4.90	24,616.30

Contract awarded to A. Brazos & Sons

Masonry for Sewer in Boulevard.

Bidders.	70-in. Sewer.	Manholes.	Total.
Bruen & Shepard, New Haven.	$14·89	$50·00	$53,309.50
Anthony Carroll, New Haven.	14·50	30.00	51,745.00
Patrick Maher, New Haven.	14·00	27·00	49,943.00
Harris & Maguire, Brooklyn, N. Y.	13.94	44·00	49,883.00
G. W. Blakeslee & Son, New Haven.	13·75	55·00	49,307.50
L. O'Brien, New Haven.	11.00	35·00	39,365.00

Contract awarded to L. O'Brien.

Proposals for Water-Works.—*Iron Mountain, Mich.*—The date for receiving proposals for the construction of water-works has been changed from April 2 to Friday, March 30. The work includes the furnishing and laying of 21,570 ft., 237 tons, of 4-in. pipe; 7,260 ft., 120 tons, of 6-in.; 5,580 ft., 120 tons, of 8-in.; 13,600 ft., 448 tons, of 10-in.; 10 tons of special castings; 50 frost case fire hydrants; 59 4-in. valves, 16 6-in., 15 8 in. and 10 10-in., with valve boxes and covers. There will be a storage reservoir with a capacity of 3,000,000 galls., a tank and a pump house. The pumping machinery will consist of 2 duplex pumps, each with a capacity of 400 galls. per minute; there will also be one turbine water wheel, with wrought-iron flume and draft tubes; also 2 duplex water motors, with a capacity of 400 galls. per minute each. Plans and specifications may be obtained at the office of the engineer, O. BURLINGAME. JOHN T. JONES is Chairman of the Water-Works Committee. The village voted last month to issue bonds for $85,000 for the water-works.

Merritton, Ont., Canada.—The Water Commissioners will receive proposals until March 14 for excavation, stone lining, masonry, etc., for the construction of a settling pond near Lock 25, new Welland canal. Also for about 4¼ miles of trenching, laying pipe and setting hydrants, valves, etc. R. CLARK is Secretary of the Commission.

Proposals for Sewers.—*Norwalk, Conn.*—Proposals for constructing sewers will be received until March 20 by JOHN D. KIMMEY, Chairman of Sewer Committee. The following are the approximate quantities: 50 lin. ft. of pile and plank channel, including 50 cu. yds. of mud excavation; 150 ft. of 30 in. stoneware vitrified pipe sewer (ring joint), pile foundation, concrete an 1 stone parapet wall included in price per ft.; 25 lin. ft. (railroad section) and 90 ft. (regular section) of 30-in. brick sewer; 1,150 ft. of 24-in. cement pipe, by Pierson of Brooklyn; 2,964 ft. of 18-in. stoneware pipe (round), 1,070 ft. of 15-in. and 5,424 ft. of 12 in.; 150 ft. of 12-in. stoneware pipe in concrete; 625 ft. of 12-in. stoneware pipe for catch basin outlets; 84 manholes, 26 catch basins, 500 hubs; 700 cu. yds. rock excavation; 192 ft. of 6-in. vitrified pipe for house connections. CHARLES N. Wood is the engineer.

Trenton, N. J.—Proposals for the following work will be received by W. W. L. PHILLIPS, Chairman, Sanitary Committee, until March 20. Main sewer: 2,000 ft. 15-in. pipe, 2,000 ft. brick from 20 × 30 ins. to 33 × 45 ins., 400 ft. of 42 and 24-in. pipe, 500 ft. of 12 and 15 in. vitrified relief pipe, 15 manholes and flushing basins. Pipe sewer, 800 ft., 8 and 10 ins., with 2 manholes. Pipe sewer, 3,000 ft., 8 to 20 ins., with 9 manholes and flushing basins. Rain water drain, brick, 3,300 ft., from 22 × 33 ins. to 48 × 60 ins., with 13 manholes and flushing basins' and 18 inlets. Rain water drain, brick 175 ft., 38 × 57 ins. Plans and specifications at the office of the engineer, 18 W. State St., Trenton.

Raleigh, N. C.—Proposals for furnishing materials and constructing system of pipe sewers, about 20 miles, will be received until April 2. J. L. LUDLOW, Engineer, and C. G. LATTA, Chairman, of the Sewerage Committee.

Water-Works.—*Herkimer, N. Y.* The following were the proposals received by the Water Commissioners: Complete works; Dennison Cowell, Muscatine, Ia., excepting stand-pipe, $32,000; Adam Miller, Saratoga, excepting pumping engine, boiler and stand-pipe, $32,500; Moffett, Hodgson & Clark, $47,222.18; John Lockwood, New York, $52,711.—Stand-pipe: Philo S. Curtis, Utica, $6,600; Chas. Millar & Son, Utica, $6,700; Porter Mfg. Co., Syracuse, $7,150; Brown & Doyle, Mohawk, $8,700.—Engine and boiler. Chas. Millar & Son, $2,800; Brown & Doyle, $3,300; P. S. Curtis, boiler $750; Porter Mfg. Co., boiler $655. The three lowest bids were, Beckwith & Quackenbush, $43,867; Brown & Doyle $45,323; Chas. Millar & Son, $47,632. J. R. & F. K. BAXTER, of Utica, are the engineers. The contract was awarded to Beckwith & Quackenbush for $42,928.52 complete, excepting the driven wells. Work to be completed by Aug. 30.

The Union Construction Co. has been incorporated by W. FRANK CARR, of Minneapolis, Minn.; FRANK H. TODD, of St. Cloud, Minn., GEO. W. and CHAS. F. STURTEVANT. The company proposes to build water-works, sewers, etc. Capital stock, $50,000.

Rails.—The Cross Town Street Railway Co., of Orange, N. J., has awarded the contract for rails for 4 miles of track to the Johnson Steel Rail Co., of Johnstown, Pa.

Depot.—V. J. Hedden & Sons, of Newark, N. J., have the contract for a large depot at Jersey City for the Jersey Central R. R. Co.

Street Lighting.—The borough of Berwick, Pa., contemplates contracting for a system of street lighting. From 40 to 50 lights will be required. Address C. H. ZEHNDER, Chairman, Street & Light Committee.

Pipe Sewers.—The following proposals for laying terra-cotta sewers, the district furnishing the pipe, have been received by Col. RAYMOND, Engineer Commissioner, Washington, D. C.: John J. Cudmore, 84 cts. per lin. ft. for 12-in., 97 cts. for 15-in., $1.09 for 18-in., $1.37 for 20-in. James McCandlish, 84 cts., 98 cts., $1.99, $1.87.

Belgian Blocks.—The following proposals have been received by ALBERT B. HILL, City Engineer, New Haven, Conn.: C. W. Blakeslee & Sons, $1.10 per sq. yd.; C. H. Miller, $1.12. Contract awarded to C. W. Blakeslee & Sons.

Brick Work.—Eugene Esleeck has been awarded the contract for the brick work for the reservoir and buildings for the new water-works at Portsmouth, Va.

RAILROADS

East of Chicago.

Existing Roads.

Cincinnati, Jackson & Mackinaw.—

VAN WERT, Ohio, Feb. 16, 1888.

EDITOR ENGINEERING NEWS:

During 1887 track was laid on extensions of our road from Ce il, O., to Addison, Mich., 60 miles; from Germantown to Carlisle, 5 miles; from Lewisburg to quarries, 1.5 miles, and from Germantown to Mudlick, 2 miles.

J. W. RIMER, *Chief Engineer.*

Quebec & Lake St. John.—The stockholders have ratified the contract with H. J. BEEMER for building several branches and inaugurating a steamboat service on Lake St. John.

Baie Des Chaleurs.—

MONTREAL, P. Q., Feb. 21, 1888.

EDITOR ENGINEERING NEWS:

During 1887 track was laid on the extension of the Baie Des Chaleurs Ry. from Metapedia to Carleton, 40 miles.

C. N. ARMSTRONG.

Ulster & Delaware.—The Attorney General of the State of New York, has brought suit to annul the charter of this company on behalf of the town of Harpersfield, which subscribed $100,000 to a former company over 20 years ago. The line was never built through the town, and the Ulster & Delaware, which is the successor to the old company, has begun work on an extension which leaves the town of Harpersfield to one side. The suit is really brought to oblige the company to refund the $100,000 with interest, or else build its line through Harpersfield.

Central R. R. of New Jersey.—The contract has been let for the new depot at Communipaw to V. J. Hedden & Sons of Newark, N. J. The cost will be about $400,000.

Cleveland & Canton.—This company has purchased the Canton & Waynesburg road and it is supposed will complete it to Waynesburg, O., 6 miles, at an early date.

Marietta, Columbus & Lake Erie.—The project for an extension of this line to Washington C. H., Ohio, under the name of the Washington, Karshner & Marietta, is being actively pushed.

New York, New Haven & Hartford.—Norcross Bros. of Worcester, Mass., have the contract for the new depot at Hartford, Conn. The price is about $200,000.

Pittsburg & Western.—The construction of a line to connect with the Cleveland & Western at Carey, O., is again rumored.

Lackawanna & Pittsburg.—This company is to be reorganized under the name of the Western New York & Southern. It is believed that the line from Wayland to Geneva, N. Y., 46 miles, will be built this season.

Philadelphia & Reading.—The company is proceeding with great secrecy in its work of securing the the real estate and right of way for its proposed elevated tracks and depot in Philadelphia; but there is now no doubt that the proposed improvements are to be carried out in a thorough and first class manner.

New Projects and Surveys.

Terre Haute & Mississippi.—This Indiana enterprise has been defeated in its attempt to obtain $100,000 aid from the city of Terre Haute, and will probably be abandoned.

Raritan River.—This New Jersey company has sold its franchise, surveys, etc., to SIDNEY H. RIPLEY of Northampton, Mass.

Springfield & Columbus.—Parties interested in the Ohio, Indiana & Western company have filed a charter under the above name, for a road from Springfield to Columbus. This is an outgrowth of the disagreement with the Cincinnati, Sandusky & Cleveland Company.

Eastern Central.—The proposed Galion, Logansport & Chicago enterprise has been consolidated with this company. The line is projected to run from Bowerston, O., to Lafayette, Ind.

Chicago, Lodi & Southeastern.—This company has purchased 39 miles of the towpath of the old Wabash & Erie canal from Major J. J. SAFELY of Lodi. The road is to run from Covington to Terre Haute. THOS. N. RICE, of Rockville, is President.

Battle Creek & Bay City.—This Michigan company has elected A. W. WRIGHT, President and S. S. HULBERT, Secretary. The office of the company is at Battle Creek.

Lansing, St. John's & Northern.—Organized at Lansing, Mich., to build a railroad to Ithaca. F. W. SPARROW is President. A. BEMENT is General Manager.

SOUTHERN.

Existing Roads

Covington & Macon.—Grading and tracklaying are making rapid progress on this Georgia road.

Cape Fear & Yadkin Valley.—The city of Wilmington, N. C., has voted $150,000 to this company in aid of the extension from Fayetteville, a distance of 80 miles.

Carolina, Knoxville & Western.—The directors are considering the proposition to build a branch line to Charlotte, N. C., to connect with the proposed Char-

lotte & Weldon. About 200 hands are now at work between Greenville and Knoxville.

East Tennessee, Virginia & Georgia.—The survey for a line from Jesup, Ga., to Jacksonville, Fla. is nearly finished. The distance is about 42 miles. Tracklaying is completed on the Mobile & Birmingham Railroad.

Atlantic & Danville.—This company has purchased the Norfolk, Chesapeake & Carolina Railroad, about 20 miles in length, used principally as a lumber road, and will use it in getting out lumber and ties for their western extension. Grading is to be completed to Hicksford by June 1, and track is to be laid by the first of September.

Savannah, Florida & Western.—Contracts will be let soon for the erection of a new passenger depot at Savannah.

Louisville & Nashville.—The Kentucky legislature has passed an act authorizing the company to double track their road from Louisville to Lexington, and straighten and improve their line.—A press dispatch from Knoxville states that the company has a corps of engineers surveying a line from Jellico, to that city, about 65 miles. It is probable that the survey is not in the interest of the Louisville & Nashville.—It is reported that the Birmingham Mineral Belt road will be extended from Helena to Woodstock, and that work will begin soon on the Huntsville extension.

Charleston, Cincinnati & Chicago.—Fifteen corps of engineers are reported at work on the final location of the line between Marion, N. C., and White House, Ky., about 400 miles, and it is stated that the whole line will be put under contract within 60 days.

Louisville Southern.—Track is laid for a distance of 18 miles from Louisville, and from Harrodsburgh north, 12 miles. It is hoped to complete the entire line by April 10.

Rome & Decatur.—The track is to be laid at once on the gap between Rome & Gadsden, Ala.

Atlanta & Florida.—The tracklayers have reached a point 45 miles from Atlanta.

Central R. R. of Georgia.—

COOSA MOUNTAIN TUNNEL, Ala., Feb. 24, 1888

EDITOR ENGINEERING NEWS:

The headings of the Coosa Mountain Tunnel met at 11 P. M. yesterday. This tunnel is on the extension of the Columbus & Western Ry.—extending from Goodwater to Birmingham—all now a part of the Georgia Central system. It is the longest tunnel in the State, being 2,420 ft. from portal to portal—directly through the base of Coosa Mountain, and 532 ft. below the summit. The contract for building was let in December 1886, to Dunavant, Tate & De Bardeleben, and work was commenced on the approaches, immediately afterward. The headings were begun about Feb. 20, 1887; 2,420 ft. of heading, therefore, has been driven during 12 months, being an *average* of 100 ft. per month in each heading since the commencement. The progress for the last month has been much above the average, about 300 ft. The tunnel was driven through alternating strata of shales and very hard sandstone, the shales predominating. The rapid and regular progress of the work has been due, in a great measure, to the untiring energy of Mr. R. C. HUNT, Superintendent for the contractors. The headings met at a distance of 1123 ft. from the east portal and 1,297 ft. from the other. The cross section of the tunnel, adopted by the Chief Engineer, Capt. F. Y. DABNEY, is 20 ft. 2 ins. in clear height, from top of rail to roof of tunnel, by 16 ft. clear width. This height makes room for the tallest man, standing on top of the highest car, to pass in safety. It is expected that the remaining bench will be taken out, the necessary trimming done, and track laid within the next sixty days. J. A. BAKER, *Resident Engineer.*

The contracts for the extension of the Buena Vista & Ellaville to Columbus, about 37 miles, will probably be let soon.—A branch is projected from the Columbus & Western Ry., near Birmingham, to Bessemer.—Rumors in New York financial circles of a proposed consolidation of this system with the Richmond Terminal have probably little foundation.

New Projects and Surveys.

Farmville & Powhatan.—About 200 hands are at work on the grading of this road, which is to run from Powhatan, 18 miles from Richmond, on the Richmond & Danville Railroad, to Farmville, about 100 miles. H. A. WHITING is Chief Engineer. JAS. R. WERTH, 703 East Main St., Richmond, is interested.

West Virginia, Pineville & Tennessee.—This company has been chartered by the Kentucky legislature to build a railroad from Pineville to some point on the Big Sandy river. JOHN H. WHALLEN, JOHN M. SHARP, THOMAS ANDERSON, and others of Louisville, Ky., are the incorporators.

Wilmington, Onslow & East Carolina.—The city of Wilmington, N. C., has voted $100,000 to this company and grading has begun in Pender county. EUGENE MARTIN of Wilmington is Secretary.

Berkeley Springs & Potomac.—

BALTIMORE, Md., March 5, 1888.

EDITOR ENGINEERING NEWS:

The Baltimore & Ohio Railroad Company have the contract to build the Berkeley Springs & Potomac Railroad, and are about commencing operations now.

B. F. DEFORD, *President.*

Atlantic, Atlanta & Great Western.—Col. GEO. T. FEY, of Atlanta, the President and chief mover in this Georgia project, is having excellent success in obtaining local aid, and right of way, and expects to let contracts this spring. For a full account of this enterprise, see our issue of Jan. 14.

Wheeling, Wellsburg & State Line.—This company is making good progress in obtaining local aid and right of way for its projected line through the West Virginia panhandle. SAMUEL GEORGE, Wellsburg, W. Va., is President.

Atlantic, Henderson & Virginia.—This company has been organized at Henderson, N. C., to build a railroad to some point on the Atlantic Coast Line. WM. H. S. BURGWYN is President.

Athens & Jefferson.—The building of this Georgia road, 18½ miles in length, is again being considered.

Danville & North Carolina.—This company has been organized at Danville, Va., to build a railroad from Danville to Madison, N. C., the terminus of a branch of the Cape Fear & Yadkin Valley Ry.

Eastern, Barnwell & Western.—

BARNWELL, C. H. S., C., March 5, 1888.

EDITOR ENGINEERING NEWS:

Our line is in close sympathy with the Augusta & Chattanooga road, now under construction. The line will begin at Charleston, S. C., and run *via* Barnwell C. H., to Augusta, Ga. A branch will also run to Aiken, S. C., where we will connect with the Cumberland Valley Unaka R. R. [Nashville & Charleston. Ed.] and another will run from the same point to the Savannah river, which will be the initial point for a line to Birmingham, Ala. This is now the most important enterprise on foot in the Southern States, as it will soon require double track from the junction near Barnwell to Charleston to do its business. Surveys will begin within 60 days, and contracts will be let as soon as possible.

W. H. DUNCAN.

THE NORTHWEST.

Existing Roads.

St. Louis & Central Illinois.—Grading has begun on the extension to Alton.

Lake Erie & Western.—Tracklaying is in progress on the 15-mile gap in the Peoria extension. The grading is all done and the line will probably be open for business soon.

Missouri Pacific.—Tracklaying on the extension formerly known as the Pacific Ry. in Nebraska, was completed to Hastings, Neb., on March 2. The line from Talmage to Crete will be ironed at once.

Cedar Falls & Minnesota.—MORRIS K. JESSUP and GEO. J. FORREST of New York City, acting as trustees for the construction mortgage bondholders have brought suit against the Illinois Central Company to oblige it to pay the rent of the Cedar Falls road and to keep the road in good repair.

Duluth, Huron & Denver.—This company, whose headquarters are at Sauk Center, Minn., and which did some grading on "an air line to Duluth" last summer, has fallen into financial difficulties. The grading contractors are trying to get their pay for the work done.

St. Paul, Minneapolis & Manitoba.—Minnesota people seem to have little belief in the statement of President HILL that the extension policy is to be discontinued. A delegation recently visited St. Paul to urge the early construction of the line from Fergus Falls to Leech Lake. According to reports, "Vice-President CLOUGH could not promise that the work would be begun at once, but led the gentlemen to believe that the work would be begun as soon as possible and completed this year."

Manitoba.—It is now generally understood that the Manitoba Central syndicate headed by J. B. MCARTHUR and T. C. SCOBLE of Winnipeg, is the one which made the offer to Premier GREENWAY to complete the Red River Valley road. Another enterprise which promises relief from the Canadian Pacific monopoly is the Ontario, Manitoba & Western, which proposes a railroad from Port Arthur to Winnipeg and thence to Morris and Portage La Prairie. From present indications the agitation in Manitoba for railroad competition will be even more serious this year than last.

New Projects and Surveys.

Chicago, Oquawka & Kansas City.—A meeting of this company was held on Feb. 29 and JOHN S. THOMPSON of Chicago was elected President, JAS. HARLAN of Mt. Pleasant, Ia., Vice President. This is the company which proposes a line from Kansas City to Oquawka Ill., bridging the Missouri river at Quindaro, and utilizing the old grade of the Parkville & Grand River Railroad to Lathrop, Mo.

THE SOUTHWEST.

Existing Roads.

Missouri Pacific.—Some trouble has arisen in regard to the right of way for the Lexington, Boonville & Jefferson City extension between Marshall, the present terminus, and Boonville. The bond by which the citizens agreed to give the right of way required the road to be in operation through Saline county by March 2. The contractors are unable to do this and are trying to secure an extension of time.—An extension in Texas from La Grange west through Schulenburg Hallettsville, Victoria and other towns has been asked for and the citizens are raising subscriptions in aid of the extension. If the company refuses to build, the citizens may form a stock company and construct a independent line.—It is reported that the company has secured control of the Lawrence & Emporia road extending from Lawrence, Kan., to Carbondale and will complete it to Osage City. By a trackage contract with the Union Pacific for use of the line between Lawrence and Kansas City, through trains will be run from Pueblo, Col., directly to Kansas City, avoiding the present roundabout route *via* Paola.—The citizens of Ste. Genevieve county will petition for the construction of the Mississippi River railway for which surveys were made last summer.

St. Louis & San Francisco.—An item is going the rounds of the newspaper press stating that the company has filed "a certificate of authorization for the issue of additional bonds to the amount of $71,144,000, in a large number of counties in Missouri, Kansas, Arkansas and Texas. It means the early completion of the proposed 'Frisco' extensions." Truly, "great oaks from little acorns grow." Probably President WINSLOW and the officers of the company will be somewhat surprised to learn that they are to float a seventy million bond issue. The company *did* issue bonds to the amount of *seven* million, one hundred and forty-four thousand dollars last month—to retire an exactly equal amount which mature on July 1.

New Projects and Surveys.

Chicago, Hannibal & Springfield.—

421 *Rialto Building,*
CHICAGO, Ill., Feb. 29, 1888.

EDITOR ENGINEERING NEWS:

Our line now under survey from Hannibal to Springfield, Mo., will tap 13 counties in Missouri with a population of 400,000. The assessed valuation of farming lands, etc., $100,000,000. Total population of towns on line in Missouri is 60,000. Six roads now center at Hannibal and four at Springfield. Surveys were begun in December, and right of way has been secured for 250 miles including terminal facilities. The maximum gradient is 1 per cent. and work is generally light. There will be one large bridge across the Missouri. ROLAND C. NICKERSON of Chicago is President, and W. E. WILLIAMS, Mexico, Mo., is Chief Engineer.

JOSEPH LATHROP, *Sec. and Treas.*

White & Black River.—Incorporated in Arkansas to build a line 75 miles long from Jacksonport to the Arkansas and Missouri State line.

Mountain View.—Organized at Hot Springs, Ark., to build a short line. Capital stock, $50,000. GEO. W. BAXTER is President.

Waco & Brazos Valley.—A preliminary survey has been made by Chief Engineer STEPHEN TURNER from Waco to Cameron, 85 miles. The locating survey was begun on March 7, and according to the Galveston *News*, "President Cameron says that the cross-ties of the Waco and Brazos Valley Railway will crush the first violets of the Spring of 1888." It is not the custom in building railways in the North to lay the ties directly upon the violets in the natural sod. Some grading is usually considered advisable, and broken stone for ballast is generally conceded to have certain advantages over violets.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Montana Central.—For the following data of construction on the Montana Central we are indebted to Mr. E. H. BECKLER, Chief Engineer. Track was laid during 1887 from Great Falls to Helena, 98.3 miles, and since Jan. 1, the line from Great Falls to Sand Coulee, 16 miles, has been completed. The lines from Helena to Butte, 73 miles, Marysville Junction to Marysville, 7 miles, and Helena to Red Mountain, 15 miles, are all under construction and for the most part well advanced toward completion. The most important works on these lines are the Wickes Tunnel, 6,120 ft. in length, of which 3,100 ft. are now completed, and a viaduct at Corbin, 98 ft. high and 705 ft. in length. A branch is proposed from Bowlder to Elkhorn, 20 miles and also two short branches known as the Cataract Creek and Basin Creek branches, 4 and 6 miles in length.

Colorado Midland.—Tracklaying is to pushed on the line from Glenwood Springs west and it is expected to reach New Castle in April.

Union Pacific.—We are authoritatively informed that two parties of engineers are surveying the proposed line from Milford, Utah, to Barstow, Cal. The length of the extension will be about 305 miles. There is no doubt that the Union Pacific would find it largely for its advantage to adopt a liberal extension policy, and if its Government obligations can be placed upon a definite basis, it will probably begin work at once upon this and several other extensions. Officers of the Colorado division of the Union Pacific have chartered the Lincoln & Colorado Ry. Co. to build a line from some point on the Kansas Pacific to Colorado Springs, also from River Bend to Denver. The latter is intended for a cut-off to shorten the through line to Denver.

Mexican International.—This line was opened for business March 1, from Piedras Negras, opposite Eagle Pass, Tex., to a connection with the Mexican Central at

Torreon, a distance of 383.11 miles. The general offices are at Piedras Negras. L. M. JOHNSON is General Manager. The line has been built by C. P. HUNTINGTON and will form part of the Southern Pacific system. It is reported with some probability that from some point on this line a branch will be built to the Mexican National line. A number of branches will also be built when required, to develop coal deposits.

New Projects and Surveys.

Palmdale.—

OAKLAND, Cal., Feb. 20, 1888.

EDITOR ENGINEERING NEWS:

This road will be 6¼ miles in length, from Seven Palms on the Southern Pacific Railroad south to Palmdale. The line has been all surveyed and is in the interest of and will be built by the Palm Valley Land Co. The money is all in the treasury to pay for the road and the line will be completed in April. H. C. CAMPBELL is President and W. F. MILLER is Chief Engineer.

F. M. BUTLER.

Monterey.—A railroad is projected from Monterey, Mex., *via* Victoria to some seaport in the State of Tamaulipas, either Soto, Lamarini or Tampico. The managers of the company have deposited $20,000 with the Government as security that the road will be built, according to contract.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(*Specially Communicated.*)

(CONTINUED FROM PAGE 167).

Florence, Ala.—The works were commenced Oct. 1, 1887, and accepted Dec. 25, 1887; they were designed by CHARLES BOECK, of Atlanta, Ga., and WM. H. BRUNDIGE, of Florence, was Constructing Engineer. The contractors were, Mills & Storey for masonry and foundations, J. W. Nichols & Co. for buildings and reservoir, Blake Steam Pump Co. for pumping machinery, South Pittsburg Pipe Works for pipe and specials, Ludlow Valve Co. for valves and hydrants, Wm. H. Brundige for special fittings, trenching and pipe laying. The prices paid were 12 cts. per lin. ft. for trenching and 6 cts. per lin. ft. for pipe laying. The reservoir is 250 ft. above the pumping station. The franchise is owned by the Cypress Water-Works Co., capital stock $10,000; President, A. BROWN; Secretary, J. B. WHITE; Superintendent, WM. H. BRUNDIGE. The present population is estimated at 4,000. There are 2½ miles of 4-in. and 6-in. cast-iron mains, 30 taps and 6 hydrants. The service pipes are of iron. The city pays $50 per hydrant per annum for 20 years. The daily consumption is about 5,000 galls. The supply is drawn from Cypress creek and pumped to reservoir by a duplex pump with a daily capacity of 300,000 galls. The pressure is 35 lbs. The works cost $10,000 and there is no debt; the annual revenue is $300 from consumers and $300 from the city; the annual expense is estimated at $300. The mains will be extended this summer.

Waterville and Fairfield, Me.—The works were commenced in June, 1887, and accepted in November, 1887; they were designed by H. G. DENNIS, of New Bedford, Mass., who was also Constructing Engineer. The masonry, foundations and buildings were done by the water company. The trenching, pipe laying and reservoir work was done by J. J. Newman, of Providence, R. I.; the pumping machinery was supplied by the Deane Steam Pump Co., of Holyoke, Mass. The pipe and specials by the McNeal Pipe & Foundry Co., Burlington, N. J.; the valves and hydrants by the Chapman Valve Mfg. Co., Indian Orchard, Mass. The reservoir is 217 ft. above the main street. The franchise is for 15 years and the annual rental is $40 per hydrant. The franchise is owned by the Waterville Water Co.; President, G. A. PHILLIPS; Treasurer, WESTON LEWIS. The present population is estimated at 10,000.

Kansas City, Mo.—(New Works). The new works were commenced April 22, 1886; and completed and started Oct. 18, 1887. The masonry, foundation and buildings were done by day labor by the company, and the reservoir contractors were B. Corrigan for earthwork and W. L. Shepard for concrete. The pumping machinery was supplied by H. R. Worthington and the Holly Mfg. Co.; the pipe and specials by Shickle, Harrison & Howard; the valves by the Ludlow Valve Co., and the hydrants by the Holly Mfg. Co. The trenching and pipe laying was done by Thos. Walker. The works were designed by G. W. PEARSONS, and R. G. PEARSONS was Constructing Engineer. The franchise is for 20 years and the price per hydrant is $30 to $40 per annum. The franchise is owned by the National Water-Works Co. (of New York); President, G. E. TAINTOR Secretary, ROBT. WEEMS; Superintendent, B. F. JONES. The present population is estimated at 180,000. (These works were fully described by Mr. G. W. PEARSONS in our last volume).

Special Reports of Water-Works Construction.

The fourth yearly edition of the *Statistical Tables of American Water-Works* will be published as the ENGINEERING NEWS' MANUAL OF AMERICAN WATER-WORKS, and the change of name will be accompanied by such an enlargement of the scope of the work and such improvements in its completeness and correctness, as will make the volume *indispensable* to every manufacturer, engineer and contractor in any way interested in Water-Works construction and maintenance, and of great value to Water-Works superintendents and projectors of new works

We are now receiving reports from all parts of the country for use in compiling this book, and abstract the news of immediate importance below. We trust our readers will kindly aid us in making the Manual of American Water-Works as complete as we desire, by notifying us of any new works under construction or projected, which they do not see mentioned in our columns. Blanks for reports of existing works or works newly projected will be sent on request.

ATLANTA, Ga., March 3, 1888.

EDITOR ENGINEERING NEWS:—Our works have a 3,000,000 gall. Hyatt filter which has been in use since November 1887, and is an eminent success in every respect.

WM. G. RICHARDS.
Supt. City Water-Works

LANESBORO, Minn., March 2, 1888.

EDITOR ENGINEERING NEWS:—I return herewith report of our water-works. They are owned by the village, and probably will not be used for other than fire purposes, as we have a river, a brook, and six large springs in the village, and obtain five wells of water, at a depth of from 20 to 60 ft. Our supply is pumped to a reservoir by a windmill, from a well 200 ft. deep. The reservoir is covered with a shingle roof and so arranged that the water in it, or in the mains, has never frozen, although the thermometer registered 40° below zero for three days during the past winter. The population of our village is 1,200

B. A. MAN, *Chief of Fire Co.*

MANKATO, Minn., Mar. 2, 1888.

EDITOR ENGINEERING NEWS:—The population of Mankato is 10,000, and the works are owned by the city. At present, our supply is by direct pumping, but we now have a reservoir nearly finished with pipes to it already laid. At present, not enough water is taken by consumers to make account of, as the water from the Minnesota river is not considered good. There is talk of changing the source of supply to wells this year, after which water will be used for domestic purposes. City Engineer, E. LILLY, is Supt.

CHAS. A. CHAPMAN.

CANTON, Dak., Feb. 28, 1888.

EDITOR ENGINEERING NEWS:—The population of Canton is 1,743. The city proposes to let contracts for water-works about May 1. The supply will be from an artesian well, and will probably be pumped to tank. The works are estimated to cost $10,000. The city has voted bonds for their construction.

T. T. LAESON.

GONZALES, Tex., Mar. 1, 1888.

EDITOR ENGINEERING NEWS:—We are now adding to our water-works an iron stand-pipe 12 ft. in diameter, and 100 ft. high.

T. S. WALKER, *Supt. Gonzoles Water Co.*

WATER.

A Geologist Wanted:

SOUTH KAUKAUNA, Wis, March 3, 1888.

EDITOR ENGINEERING NEWS: The citizens of Kaukauna are at present agitating the question of water-works, and have had water from different wells, and also the river water, analyzed without satisfactory results.

I am requested to write you as we wish information in regard to the supply and character of water liable to be found in this locality by artesian wells. Can you recommend some geologist with whom we can correspond with advantage on this subject?

F. M. CHARLESWORTH.

The Crown Meter.—As a result of recent utterance of Mayor O'Brien of Boston, on the subject of meters, the following petition was senf to the Board of Aldermen on Monday last:

To the Honorable the City Council of the City of Boston:

Respectfully represents the National Meter Co., that on the twenty-seventh day of February last, His Honor the Mayor sent to your Honorable body a communication relating to the use of water meters by the city of Boston, having appended thereto certain correspondence between His Honor the Mayor and Mr. WM. F. DAVIS, Water Registrar, and also certain tables purporting to give "some positive facts" as to results obtained from meters after performing a duty of 24,000 ft. and upwards: that said communication, correspondence and tables contain statements so misleading and incorrect that their publication would work a great injury to your petitioner: that in particular, the table marked "Schedule A," so far as it purports to relate to the Crown meter, is radically incorrect: that your petitioner is able to prove that such schedule is incorrect and that most of the Crown meters therein mentioned, never were and never could have been subjected to any test by the city of Boston or any of its agents.

Therefore, your petioner prays that said communication, together with the said correspondence and schedules be referred to the Committee on Water: that said committee be directed to investigate the subject matter thereof, with power to send for persons and papers, and that they give a public hearing to your petitioner and to all other persons interested therein.

(Signed) NATIONAL METER CO.
By CHAS. H. BALDWIN,
New England Representative.

Water-Works.—*Maine.*—Farmington. At a meeting held March 2 to see if the corporation would ratify the contract made by the assessors with the Farmington Water Co. for a water supply for fire and domestic purposes, the contract was rejected by a vote of 161 to 75.——Eastport. N. B. NUTT is Secretary and Treasurer of the water company which is now negotiating with the National Water-Works Syndicate, of Boston.

New Hampshire.—Dover. The petition of B. T. Whitehouse for an injunction to restrain the city from exceeding an expense of $275,000 for the new water-works has been dismissed by the Supreme Court on the ground that while the city contemplated exceeding this amount, it had not done so.

Massachusetts.—Needham. A bill authorizing a water supply to be established has passed the Senate.——Malden. The special committee on additional water supply has reported that the results of the test of the wells at Eaton's meadows were satisfactory, an average of 825,000 galls. having been pumped for 65 days. The Legislature will be applied to for power to issue $100,000 additional water bonds for a supply from Eaton's meadow or other source.

New York.—Palmyra. Water-works are needed.——Springville. The water-works were tested for fire purposes on Feb. 25: the system is direct pumping.——Jamestown. The contract has been let for laying pipe to the city from the wells of the Water Supply Co. at Levant.——Ballston. The present water supply and the water pressure from the new reservoir are insufficient. It is proposed to lay mains to the old and abandoned reservoir, and obtain an additional supply.——Glens Falls. During the year 6,894 ft. of pipe have been laid, and 5 hydrants set. Water Commissioner ALBRO recommends a 16-in. main to replace a 12-in., and also about 10 miles of extensions.——Syracuse. Mayor KIRK in his inaugural address, has called attention to the important and vexed question of an adequate water supply. It is stated that until accurate information respecting the several proposed sources, has been obtained, and the right of the city to build its own works has been ascertained (the Syracuse Water Co. claiming a monopoly), the city's action should be careful and economical.

New Jersey.—Asbury Park. About $70,000 have been appropriated and expended for improving the water supply system under the direction of a Board of Water Commissioners, but the supply is now deemed quite inadequate. It is proposed to issue additional water bonds for $22,000.

Pennsylvania.—Philadelphia. Director WAGNER and Chief Engineer OGDEN, of the Water Department, have proposed a supply for the high pumping district. Pipe is to be laid from the East Park reservoir to convey water by gravity to the Spring Garden pumping station, whence it would be pumped to the district.——Braddock. The Committee appointed to consider the various filtering processes has recommended the purchase of a Jewell filter, with a daily capacity of about 800,000 galls.

Ohio.—Salem. It is reported that the Council has been asked not to accept the new water-works on the ground that the water is not pure.——Delaware. The Delaware Water-Works Co. will establish a water supply.——Uhrichsville. The city has decided to have water-works, by a vote of 461 to 29.

Kentucky.—Louisville. The Louisville Water Co. will probably put in a system of filters when the improvements contemplated (and advertised in our columns) are carried out. Chief Engineer HERMANY is in favor of a Hyatt plant, with a daily capacity of about 10,000,000 galls.—Covington. The following are the officers of the Board of Water-Works Trustees, organized March 4, President, C. J. TRANTER; Secretary N. T. LINDSEY; Treasurer, GEO. H. DAVIDSON; Chief Executive Officer, W. H. GLOBE.

North Carolina.—Fayetteville. A proposition to build the water-works has been made by Mr. De Richards, of Jersey City, N. J.

Florida.—Gainesville. The town is again talking up the question of water-works.

Alabama.—Tuscumbia. Water-works will probably be built by Wm. H. Brundige, of Florence, Ala., who also expects to build works at Tuscaloosa.

Michigan.—Pontiac. The water-works and electric light plant will be put in this spring.—Mt. Clemens. The town will probably vote for water-works this spring.

Illinois.—The Calumet Water Supply Co. has been incorporated at Chicago by B. F. PATRICK, Jr., CHAS. H. MIFFLIN and CHAS. A. TYRRELL. Capital stock, $100,000.

Dakota.—Minot. A system of water-works is under contemplation.

Arkansas.—Alexander. The new Alexander Water-Works Co. has a capital stock of $3,500. President, ESTEN PELOUBET.—Batesville. Water-works are proposed. Address A. A. WEBBER.

Kansas.—Cimarron. The city has voted for water-works, and they will probably be established this spring.

Wyoming.—Laramie. The water-works are completed and in operation.

Nebraska.—Falls City. The water bonds have been purchased at par by Spilser & Co., of Toledo, O.—Weeping Water. The election on Feb. 27, on the issue of bonds for water works was carried by 100 to 2.—Tecumseh. The vote on the issue of bonds for water-works resulted in 278 for and 6 against.

California.—Riverside. The Palm Valley Water Co. will move its offices from Los Angelos to Riverside. President, L. M. HOLT, of Riverside; Secretary, M. F. HUDSON.

Texas.—Waco. In consequence of the failure of the city to agree with the water company, the city will dig 10 cisterns and purchase a steam fire engine, in order to have fire protection.—Rockdale. Nothing definite has yet been decided in the water-works matter, but the town wants to establish a water supply very soon.

New Water-Works.—(SPECIALLY COMMUNICATED.)—***Henderson, N. C.***—The town is very anxious to get a good water supply. The town, together with some of its leading citizens, is now looking into the different plans. Population 4,000. The present supply is from wells and cisterns but the new supply must be from stream; the water will be pumped to reservoir, tank or stand-pipe and hydrant pressure will be used for fire purposes. The works will be built by the Henderson Water-Works Co., just chartered. J. R. YOUNG.

Machias, Me.—Population 2,300. The present supply is from 6 reservoirs for fire purposes; the proposed supply is from a lake about 3 miles distant. The water will probably be pumped and hydrant pressure used for fire purposes. The works will be built by a private company, not yet organized; estimated cost, $25,000; capital is being secured. The subject may be brought up at the annual meeting the last of March. It appears to be a large expense for so small a population. The people of the town are very enterprising.

JOHN R. HINES, *Chairman Board of Selectmen.*

Newport, N. H.—A charter was procured from the legislature of 1887; Hon. DEXTER RICHARD and FREDERICK W. LEWIS being named as corporators. The route is about 6 miles and has been surveyed by a Manchester firm. A route from Long Pond *via* Croydon, nearly 6 miles, has also been surveyed. The population in 1880 was 2,612, and is increasing. There is no supply at present, and the proposed supply is from Sunapee lake. There is so much fall that it will probably be necessary to construct a reservoir on a hill near the village to feed the pipe; hydrant pressure for fire purposes. The works will be built by a stock company, capital to be raised by subscriptions for stock. Probable cost of works, $50,000. Contracts will probably be let in the spring, work commenced in the summer and completed in the fall. FRED. W. CHENEY, *Town Clerk.*

Du Quoin, Ill.—Population, 4,000. Present supply from wells and cisterns; proposed supply from reservoirs; hydrant pressure for fire purposes most likely. Probable cost of works, $10,000 to $15,000. Whether to be built by city or a private company not yet determined. A water-works system will probably be established in a short time. W. B. HALL.

Eureka, Kan.—There is a proposition to vote bonds this spring. Population, 3,500. The present supply is from wells, springs and cisterns; proposed supply from Spring creek, pumped to reservoir. Steam power for fire purposes. The works will be built by the city; probable cost, $45,000; they will probably be commenced this summer and completed next year. J. W. NIER of Kansas City, Mo., is the engineer. S. A. MARTIN.

Sewerage.—***Bar Harbor, Me.***—The sewerage work has been continued during the winter and a large amount of work is done.

Boston, Mass.—Mayor O'BRIEN does not favor the proposal to petition the Legislature for a sewer loan of $500,000 outside the limit of indebtedness. He does not consider the loan necessary.

Framingham, Mass.—The town has voted to construct a system of sewerage, and will accept the offer of the city of Boston to pay $25,000 towards the cost. Bonds for $140,000 will be issued. S. C. HEALD, of Worcester, is the engineer.

Brooklyn, N. Y.—A bill has been prepared providing for a sewerage system for the 18th, 24th, 25 and 26th wards. There will be two main sewers, and the cost is estimated at $1,000,000. The outlets would be at Jamaica bay, where sewage disposal works would be established, to prevent the pollution of the bay. City Engineer VAN BUREN has helped to prepare the bill.

Albany, N. Y.—The New York Central R. R. Co. will build a trunk sewer along the valley of Patroon's creek, and the city will have the right to connect any sewers with this main sewer.

Atlanta, Ga.—The City Council has appropriated $2,600 for an examination of the present system of sewerage which is very inficient. Mr. BOYNTON is Chairman of the Sewerage Commission.

Athens, Ga.—The city is contemplating a system of sewerage and is corresponding with sanitary engineers. Address WM. MCDOWELL.

Asheville, N. C.—The city will vote in April on a proposition to issue bonds for $60,000 for sewerage.

Atchison, Kan.—The present system of sewerage is imperfect and improvements are contemplated, to cost about $100,000.

Beatrice, Neb.—A sewerage system will be established shortly. Proposals have been received recently.

Redding, Cal.—It is proposed to establish a system of sewerage, and a system of street grades.

The Extended Use of Water Motors.—A paper with this title, by J. T. RODDA, of Eastbourne, England, has been published in the *Journal of Gas Lighting & Water Supply*, England. It is stated that a large number of elevators in London are operated by pressure from the water mains; the water flows into a tank in the roof of the buildings, with a ball valve to shut off the supply when the tank is full, the water used by the elevators being wasted. The system has been approved by engineers, and water companies are recommended to supply small motors and rent them, with power, in the same way that gas and compressed air companies let out motors. Water and gas companies can do the work for intermittent use cheaper than any other special power company.

Sidney, O. March 1, 1888.

EDITOR ENGINEERING NEWS: It has been ascertained that all voting to spend money for town improvements must be done at a general election, either in April or November, hence the last two special elections on the question of water-works have been illegal. In view of this, the Mayor has called for a special vote on this question at the regular spring election the first Monday in April. This vote is intended to be a ratification of what has already been done. The necessity for water-works being imperative, and there being no doubt but that the vote will be a favorable one the Trustees of the water-works will continue in office. Our last well has been completed, and yields about 28,000 galls. a day. Plans and specifications for the remainder of the work will be submitted to contractors as soon as they are decided upon at the April election.

WILBUR A. GINN, *City Engineer.*

Morrisonville, Ill. Feb. 10, 1888.

EDITOR ENGINEERING NEWS: The source of proposed supply is a well 16 ft. diameter, 30 ft. deep, water plenty; water pumped into tank of wood, 16 ft. by 24 ft. on wood substructure 60 ft. high, with engine pressure for fire purposes. Complete plans and specifications have been prepared and bids received for constructing works, but contract not let yet. There will be a good engine and boiler, but only a small amount of ground pipe to be laid in business part of village on this contract. The population is 1,000. The city will contract for the works, which will cost about $5,000; this will be secured by bonds issued by the village, which will be sold by N. DOUGLAS RICKE, of Taylorville, Ill., April 2, by which time contracts will probably be let. Work is to be begun in the spring and completed in the fall. The engineer is Mr. JOHNSON, of Fairbanks, Morse & Co., Chicago. H. H. HERDMAN is President of the Board of Trustees of the village. W. E. FORBES, *Village Clerk.*

Schwenksville, Pa. Feb. 13, 1888.

EDITOR ENGINEERING NEWS: In reply to your letter will state our plan for our proposed water supply. Our village is small, but has some natural advantages not often found in other places. We have two hills about 80 or 100 ft. high at either end of the village; and the Perkiomen creek running right through its whole length. One mile of pipe, a small reservoir and steam pump, with about one dozen fire plugs, would be ample protection in case of fire, and also for water supply; the probable cost $5,000 to $7,000. But the people in our place think we cannot afford to erect and maintain any such works as the population is entirely too small, about 700. The chances for growth are not encouraging, and on that account our plan has failed to be effective so far. If a plan could be found that would not cost more than $2,500 or $3,000 we would be able to raise the money, perhaps. Hydrant pressure for fire purposes. The works will be built by a private company if at all, but no capital secured nor company created yet. We have still hope of getting a water supply. ALBERT BROMER.

Minneapolis, Kan.—

NASHUA, N. H., Feb. 29, 1888.

EDITOR ENGINEERING NEWS: In answer to your inquiry concerning the wells which furnish the water for the Minneapolis (Kansas) water-works, I have to say that the soil of the city of Minneapolis is a rich, clayey loam, from 2 ft. to 10 ft. in depth. This loam lies upon a sandstone formation, which upon being loosened with a pick, crumbles into sand about the consistency of coarse mortar sand. The wells throughout the city range from 40 ft. to 100 ft. in depth, and require no curbing except through the loam to the top of the sand rock. A man can easily sink a well 6 ft. per day in this sand rock, as the sides can be made just as smooth and solid as the ceiling of a room, and after exposure to the air continue to grow harder. The first well for the water-works was located about 50 ft. from the bank of the Solomon river and 35 ft. above the surface of the water in the river. The well was 6 ft. by 12 ft. and was sunk 45 ft. into the sand rock. It yielded about 30,000 galls. per day. As soon as the works were completed, there was such a large demand for water that an additional supply was imperative, as the river water, like most of the western rivers, was at no time fit for use. Accordingly after a thorough examination of the locality, another well was located 70 ft. from the first well, and about the same distance from the bank of the river. This was sunk to the same level as the bottom of the first well and each well had 13 ft. of water in depth, and as the water-works were of the direct-pressure system, and the consumption of water varied continually throughout the day, by connecting the bottom of the wells by means of a tunnel, 6 ft. square and 70 ft. long, it gave us a good sized reservoir to draw from, besides intersecting several veins of water. This tunnel required no timbering, the roof and sides being to all appearances as hard as solid rock, and I am confident that a tunnel 25 ft. wide could be driven in this material, without any trouble from caving. The new well and tunnel increased the supply to about 400,000 galls. per day. After the tunnel was completed, a 6-in. hole was drilled in the bottom of the new well, in order to ascertain if a still greater flow of water could be obtained. This hole was drilled by making a drill out of a Z shaped bit. It was lengthened out by coupling on 1¼ in. wrought-iron pipes, as the hole increased in depth. In this manner the first hole reached a depth of 73 ft. below the bottom of the well, and required to complete it only 10 hours' labor of 3 men. There was an abundant flow of water from it, which raised up much higher than the ordinary level of the well water. We afterwards drilled 3 more similar holes in this well, also 4 holes in the old well, but were unable to reach as great depth with any of the holes as we did with the first one. There is now a supply of nearly 1,000,000 galls. per day flowing from the wells and tunnel. I do not suppose there is anything novel in this manner of getting a water supply, but I am satisfied that wherever a sand rock formation abounds, there will be no difficulty in procuring an abundant supply of pure water.

H. G. HOLDEN.

Water-Works Reports.

Fitchburg, Mass.—The Water Commissioners have issued their report for the year ending Nov. 30, 1887, being their 14th annual report. There are 31,464 ft. of low service and 41 878 ft. of high service cement mains: 69,635 ft. of low service and 40,557 ft. of high service iron mains; 14,487 ft. of cement were replaced with cast-iron, and it is recommended that the work of replacing the cement mains with cast iron should be continued as fast as possible. The works were built in 1871, 1872 and are owned by the city. The supply is by gravitation from 2 storage reservoirs on Scott and Falulah brooks. The population is 20,000, 18,000 on line of pipe, 14,000 supplied. Total consumption for the year, 432,000,000 galls., of which 17,596,000 passed through domestic meters and 104,601,301 through manufactory meters. There are now 34.77 miles of mains, wrought-iron, cement-lined and cast-iron, 2 to 16 ins. diameter; during the year, 13,504 ft. were laid and 1,263 ft. discontinued. The cost of repairs for 14 miles of cement pipe was $116.29 per mile, and for 20.8 miles of cast-iron pipe, $1.19 per mile. During the year 11 hydrants were added, total, 256; 61 stop gates, total, 230. The range of pressure at City Hall for day and night is 155 to 160 lbs. high service, 78 to 80 lbs. low service. There are 26.88 miles of wrought-iron, cement and cast-iron service pipe, ¾ in. to 6 ins.; during the year 10,339 ft. were laid. During the year 204 service taps were added, total, 2,203; meters 92, total 545 (464 domestic, 81 manufactories); motors and elevators 4, total 15. CHAS. H. BROWN is President of the Board; THOMAS C. LOVELL, Superintendent.

Plymouth, Mass.—The Board of Water Commissioners have issued their report for the year ending Dec. 31, 1887. The reservoir commenced in 1886 was completed last fall, it has a capacity of 1,370,000 galls. It is lined with 5 ins. of concrete: 1 cement, 2 sharp sand, 6 gravel, coated with ¾-in. of cement and sand 1 to 1. The works were built in 1855 and are owned by the town. The supply is from Great and Little South ponds and Lout pond; the low service is by gravity and the high service by pumping. The pumping machinery is by H. R. Worthington. The population is 7,800, 6,500 on line of pipe, 6,400 supplied. Total consumption, 214,809,418 galls. There are 27½ miles of main, wrought-iron, cement lined, 2-ins. to 20 ins.; during the year 21,015 ft. were laid and 1,203 ft. discontinued. Cost of repairs per mile, $13.35. During the year 8 hydrants were added, total 75 public and 8 private; stop-gates, 35, total, 217. There are 5 miles of service pipe, lead and cement-lined, ¾-in. to 1-in.; 660 ft. were laid during the year; 33 taps were added, total 1,317. RICHARD W. BAGNELL is Superintendent.